2121

PSYCHOLOGICAL REVIEW PUBLICATIONS

THE
Psychological Monographs

EDITED BY

JAMES ROWLAND ANGELL, UNIVERSITY OF CHICAGO
HOWARD C. WARREN, PRINCETON UNIVERSITY (*Index*)
JOHN B. WATSON, JOHNS HOPKINS UNIVERSITY (*Review*) and
SHEPHERD I. FRANZ, GOVT. HOSP. FOR INSANE (*Bulletin*)

VOLUME XVIII
1914-15

PSYCHOLOGICAL REVIEW COMPANY
PRINCETON, N. J.
AND LANCASTER, PA.

AGENTS: G. E. STECHERT & CO., LONDON (2 Star Yard, Carey St., W. C.);
LEIPZIG (Koenig Str., 37); PARIS (16, Rue de Condé)

BF
1
.P972
V.18

TABLES OF CONTENTS OF VOL. XVIII

1. Mental and Physical Measurements of Working Children. HELEN T. WOOLEY and CHARLOTTE R. FISHER. Pp. 247.

2. Recognition and Discrimination. GUSTAVE A. FEINGOLD. Pp. 128.

3. Alternation and Interference of Feelings. CHESTER ELIJAH KELLOGG. Pp. 94.

4. A Study in Association Reaction and Reaction Time. HARRY W. CRANE. Pp. 73.

(This volume includes Monographs 77–80)

291648

CHAPTER I

INTRODUCTION

1. Plan and Purpose of the Entire Investigation

The present monograph is a report of a small portion only of a larger investigation. The larger investigation arose out of a desire to make a comprehensive study of the problem of child labor, with a view to furnishing a scientific demonstration of the effect of child labor on children who enter industry early. To make the study complete, it seemed necessary to include the following phases: the educational history of the children investigated; their physical development on going to work and from year to year afterward; their mental development on going to work, and from year to year afterward; the industrial history of each individual; the home environment of each individual; and general industrial conditions in children's occupations. Schedules for collecting information in each field, were worked out as follows:

STUDY OF CINCINNATI WORKING CHILD

SCHEDULE I.

NAME _____ ADDRESS _____

AGE _____ DATE OF BIRTH _____ BIRTH-PLACE _____

CREED _____ NAME OF PASTOR OR PRIEST _____

OCCUPATION: (•) FATHER _____ (•) MOTHER _____

SCHOOL ATTENDED _____ GRADE _____ LAST DAY _____

STANDING: READING _____ SPELLING _____ WRITING _____ ENG. GRAMMAR _____ GEOGRAPHY _____ ARITHMETIC _____

SCHOOL ATTENDANCE RECORD _____

SPECIAL TRAINING _____ MANUAL _____ DOMESTIC SCIENCE _____

CONDUCT _____ IF TROUBLESOME, STATE REASON _____

APPLICATION _____ PUNCTUALITY _____

REMARKS: _____

SOURCE—AGE AND SCHOOLING CERTIFICATE RECORD.

WHAT SCHOOLS HAVE YOU ATTENDED?

WHAT STUDIES DID YOU LIKE BEST? LEAST?

WERE YOU ABSENT MUCH? IF SO, WHY

DID YOU PREFER TO LEAVE SCHOOL? AGE

WORK BEFORE AGE OF FOURTEEN? BEFORE SCHOOL AFTER SCHOOL ERRAND

SELLING PAPERS PEDDLING BOOT-BLACKING OTHER EARNINGS

WHY ARE YOU GOING TO WORK,—DOES YOUR FAMILY NEED YOUR HELP?

HOME CONDITIONS

(1) WHAT IS NATIONALITY AND BIRTH PLACE OF

(A) FATHER? (B) MOTHER?

(2) LANGUAGES SPOKEN BY (A) FATHER? (B) MOTHER?

(3) LANGUAGE OF THE HOME?

(4) MOTHER, A WAGE EARNER, (A) AT HOME? (B) OUT SIDE?

(5) NUMBER OF ROOMS?

(6) LODGERS?

SOURCE—THE CHILD

The information on the face of Schedue I, is copied from the record furnished by the school, when the child applies for his work-certificate. That on reverse side is obtained from questioning the child himself in the office.

PHYSICAL EXAMINATION

SCHEDULE II.

NAME NUMBER SEX HEIGHT WEIGHT

FAMILY HISTORY

NUMBER OF OTHER CHILDREN No. OF CHILD

MOTHER'S CONDITION

FATHER'S CONDITION RHEUMATISM CANCER

TUBERCULOSIS SYPHILIS HEART DISEASE

PERSONAL HISTORY

MUMPS MEASLES WHOOPING COUGH SCARLET

DIPHERIA TYPHOID PNEUMONIA

HEALTH DURING PAST YEAR

PRESENT CONDITION

EARACHE HEADACHE EYES COUGH

EXPECTORATION NIGHT SWEATS SORE THROAT APPETITE

FATIGUE COLOR

EXAMINATION

TONSILS ADENOIDS CERVICAL GLANDS

THYROID GLAND TEETH MUCOUS MEMBRANES GUMS

CHEST LUNGS INSPIRATION EXPIRATION EXCURSION

VITAL CAPACITY HEART PULSE RATE RYTHM TEMPERATURE

SPINE POSTURE FEET SKIN RASH

Schedule II, on physical examination is merely a makeshift. In order to obtain a satisfactory record of the physical status of the children from year to year, we should, of course, have had at our command the services of a skilled physician. Since this

was impossible, we made out a schedule designed to include the few physical measurements which a lay observer can make, and a series of questions about health, past and present, which might (at least when answered in the affirmative) throw some light on physical conditions. We are indebted in connection with this schedule to Dr. Paul G. Woolley for advice and suggestions and to Dr. Frances Hollingshead for deciding on the final form of the schedule, and training some of the laboratory force in making the observations.

SCHEDULE III. PSYCHOLOGICAL STUDY OF CINCINNATI WORKING CHILD

NO. SCHOOL GRADE NAME

VIS. AC. V R. E. V L. E. AUD. RIGHT LEFT GRIP RIGHT LEFT

TAPPING — RIGHT: SECONDS (1 - 15, 15 - 30, 30 - 45, 45 - 60) TAPS; SECONDS (1 - 30, 30 - 60, 1 - 60 FATIGUE INDEX) TAPS — LEFT: SECONDS (1 - 15, 15 - 30, 30 - 45, 45 - 60) TAPS; SECONDS (1 - 30, 30 - 60, 1 - 60 FATIGUE INDEX) TAPS

CAUSE AND EFFECT PAUSES: NO. DONE; % PERFECT; % CORRECT; % PARTIALLY CORRECT; 1 SEC, 2 - 3, 4 5 TIME; 6 10, 11 20, 20 30 INDEX

SUBSTITUTION: SECTION 1 2 3 4; TIME; ACC; INDEX; SERIES 1 2 AV SPAN

MEMORY: 7 PLACE; 8 PLACE; 9 PLACE

STEADINESS: HAND; HOLE; CONTACTS; RIGHT; LEFT

A TEST: TIME; ACC; INDEX — OPPOSITES: TIME; ACC; INDEX

CARD SORTING: TIME; ACC; INDEX; ERRORS

FORM BOARDS: A: TIME; MOVES; IMP. B: TIME; MOVES; IMP. FLOWER POT: TIME; MOVES; IMP. EGG: TIME; MOVES; IMP.

SENTENCES: 1—NO DONE (0—NO. SIMPLE (A); 0—PHRASES (B) 2; 1—NO. IDEAS); 2—NO CORRECT (A) COMPLEX (B) (B) 5-8; (C) 9-10; (D) 11-20; 0— INDEX; INCORRECT (B) 0— TIME (E) 21-30

DATE OBSERVER

Schedule III gives the list of tests used as a measure of mental development. The tests are repeated from year to year, with changes of form when necessary. Some tests were added in the second and third years which are not on the list for the first year. The only test so far applied which does not appear at all in Schedule III, is the puzzle box test which has been given to the fifteen- and sixteen-year-old children.

Schedule IV is the form in which the industrial histories of the working children are kept. The list of employments, with the salient facts about each, appears on the face of the schedule. The questions on the reverse side are indicated so briefly that they need a little interpretation. The two questions about fatigue (No. 2) are (a) whether the child found the employment very

STUDY OF CINCINNATI WORKING CHILD

INDUSTRIAL HISTORY
SCHEDULE IV

No. Name

JOBS	DATE OF TAKING	DATE OF LEAVING	USE OF UN-EMPLOYED TIME	INDUSTRY	KIND OF WORK
1					
2					
3					
4					

	HOURS	OVERTIME	EARNINGS TIME PIECE WEEKLY	HOW FOUND	CHILDS REASON FOR LEAVING	EMPLOYERS REASON FOR LEAVING
1						
2						
3						
4						

JOBS	1	2	3	4
1 EASE OF FINDING				
2 FATIGUE a				
FATIGUE b				
3 EARNINGS a				
EARNINGS b				
4 APPRENTICE a				
APPRENTICE b				
5 CONTINUATION OF EDUCATION				
6 RELATION OF STUDIES TO WORK				
7 ENJOYMENT OF WORK				
8 FREE TIME				
9 WORK AND SCHOOL a				
WORK AND SCHOOL b				
10 COMBINATION OF WORK & SCHOOL				

fatiguing at first and (b) whether he continued to find it fatiguing after becoming accustomed to it. Under the head "earnings," (a) is how much of the child's earnings was given to the parents, and (b) how much of an allowance of spending money the child received, in case he gave all his earnings to his parents (as most of them do). With regard to apprenticeship (No. 4), question (a) is "Are you learning any trade which will be permanent for you?" and (b) is—"What trade or occupation would you like to take up if you had your choice?" No. 8, is a question as to the way in which evenings and Sundays are spent;

No. 9, (a) is whether, after trying both work and school, the child prefers work (they do with very few exceptions) and (b) is whether they feel that they are learning as much at work as they did at school. Question 10 has reference to their attitude toward continuation school.

SCHEDULE V — STUDY OF CINCINNATI WORKING CHILD

NAME — ADDRESS — NO.

NEIGHBORHOOD: GENERAL CHARACTER — RESIDENCE OR INDUSTRIAL — NATIONALITY

HOME: G. T. TYPE OF BUILDING — CONDITION OF BUILDING — PREMISES — TOILET

NO. OF ROOMS — FLOOR — FRONT OR REAR — LIGHT — VENTILATION — WATER LOCATION

ORDER — CLEANLINESS — FURNISHINGS

FAMILY: OWN OR GUARDIAN — TOTAL NO. IN HOME — P. CH. FAMILY AT HOME — BOARDERS — LODGERS — MARRIED OR AWAY — DEAD

HEALTH RECORD — CAUSE OF DEATH

F. M. NATIONALITY — REMARKS

WAGE EARNERS	KIND OF WORK	WEEKLY EARNINGS	AM'T KEPT FOR SELF	UNEMPLOYMENT	EXPENSES
					RENT Month
					FOOD Week LUNCHES
					INSURANCE
					INSTRUCTION SAVINGS

CHILD: HOME RESPONSIBILITY — USE OF SPARE TIME — TRADE AMBITION

PARENTS' REASON WHY CHILD STOPPED SCHOOL — USE OF EARNINGS

PARENTS' ATTITUDE TOWARDS CHILD'S EDUCATION — 1-A — 2-B — 3-C — 4-D — E — SPECIAL SCHOOL — CHILD'S WORK — 1 — 2 — 3 — A-B — 2-7

PARENTS' ATTITUDE TOWARDS CHILD — 1-A — 2-B — 3-C — 4-D — 5-E — 6-F

GENERAL IMPRESSION OF HOME

DATE — INVESTIGATOR — SOURCE OF INFORMATION

OVER

Schedule V records the results of home visits. It is rarely possible to obtain all the facts indicated on the card about any one home, but the visitors do their best to do so. The key to the cipher at the bottom of the card is as follows:

Parents' attitude toward child's education.

1. Able to send to school. A. Unable.
2. Willing to send to school. B. Unwilling.
3. Disappointed because child cannot continue. C. Natural thing for child to stop.
4. Anxious for child to continue in future. D. Indifferent to more education.
5. Merely yields to child's wish to stop.

Parents' attitude toward child's work.

1. Definite plans.
2. Vague plans.
3. No plans.

A. Interested in work.
B. Indifferent. Little knowledge of work.
X. Encouragement to child.
Y. Little or no assistance or inspiration to child.

Parents' attitude toward child.
1. Interest. (A) Indifferent.
2. Sympathetic. (B) No sympathy.
3. Indulgent. (C) Severe.
4. Retains guidance or control of child. (D) No control.
5. Regards child as an individual. (E) Regards child merely as an asset.
6. Ambitious for child. (F) Not much knowledge of child.

Under "General Impression of Home," the investigators tried to keep the following points in mind.
Is the atmosphere cheerful or depressing?
Is the home attractive or unattractive?
Does it indicate thrift or shiftlessness?
Are the parents intelligent or ignorant?

FIRM ADDRESS TRADE DEP'T
LEARNER'S AGE MIN. WAGE FUTURE
SCHOOLING: NECESSARY SUPPLEMENTARY
PROMOTION
UNION LEARNER'S RULES
FINES AND BONUSES
EMPLOYEES: OVER 18 M. F. UNDER 18 M. EARNINGS: PLAN
MALES: UNDER $9 $9 TO $14 OVER $14 FEMALES. UNDER $8 $8 TO $11
OVER $11 MAX.: MALES FEMALES MIN.: MALES FEMALES
WORK DAY
OVERTIME HOME WORK
SKILLED LABOR: OBTAINED? SUFFICIENT?
SEASONS MAX. FORCE: M. F MIN.: M. F
WORK ROOM LIGHT AIR CLEANLINESS SPACE NOISE LUNCH FACILITIES TOILETS ISOLATION
WELFARE WORK
REMARKS

Schedule VI states the main points which we try to discover in investigating any industry. It has proved to be of less practical value as a record form in making investigations than any of the others.

It was evident from the first that in order to be able to interpret our series of physical and mental measurements of children in industry, it would be necessary to have a control series of

children who remain in school. Accordingly the office has undertaken to apply the same régime, in so far as it is applicable, to a corresponding series of children who remain in school. The school children will have schedules I, II, III, and V, filled out for them,—in other words, all the schedules except those dealing with industrial life.

Such is the scope of the entire investigation. Although it was planned largely with the purpose of ascertaining the effects of child labor, its applications to the vocational phases of the problem have been from the start, more or less in mind. The growing interest in vocational guidance and vocational education have served to throw more and more stress on that side. It is particularly the use of experimental psychology as a tool in vocational guidance, on which such a series of investigations seems capable of throwing light. At least one good way of testing the usefulness of experimental psychology as a guide in vocational advising, is to apply a representative series of psychological tests to a large and fairly homogeneous group of young people and then find out how much, if any, correlation exists between the outcome of the tests, and industrial success or failure in various directions. The psychological tests have been employed, therefore, not with a feeling of certainty that they would prove satisfactory in either field, but with the conviction that they offered sufficient promise as a method to make them worth trying; and furthermore, that trying them consistently and on a large scale was the only sure way of testing their value. It is the tests, therefore, which are being investigated quite as much as the problems of child labor or vocational guidance.

2. Material Presented in this Monograph

Any one who has had experience in evaluating and summing up series of experimental results will readily appreciate the amount of labor involved in evaluating and summing up even one series of a dozen or more tests applied to 750 individuals, particularly if the work is done with care and precision, and constant verification of results as ours has been. Perhaps it is

unnecessary to apologize then, for the comparatively small amount of material offered in this monograph. It consists merely in a complete statement of the methods of administering tests, and dealing with results, together with the outcome of the tests for fourteen-year, and fifteen-year series of working children. The statement of results includes percentiles for the sexes separately for each measurement involved, correlations with the school grade of the children, comparisons of the two sexes, comparisons of the two types of schools represented, (the public and the parochial schools), and comparison of the two ages. We are well aware that the comparison of the series of working children with that of the children remaining in school, or the question as to what correlations, if any, exist between the mental and physical measurements of working children, and their industrial successes and failures, are matters of far greater interest to everyone, while to psychologists the correlations of one test with another would also be more interesting. However, none of these series of results is as yet complete, and the facts presented here, are a necessary preliminary to the interpretation of them when obtained. The detailed description of methods of administering tests, of evaluating results, and of making summaries, is given once for all, here. All future reports presenting further results, will refer back to this one.

3. History of the Investigation with Special Reference to the Psychological Portion

The investigation was planned and its general scope determined by Miss M. Edith Campbell, of the Schmidlapp Bureau of Cincinnati, and Mr. E. N. Clopper of the National Child Labor Committee. They solicited the money for it, and have constituted the Board of Directors from the beginning. The idea of making such an investigation was suggested to them by the passage of a Child Labor Law in Ohio in 1910, which required the reissuance of working certificates every time the children change positions, and thus gave to the office of the Superintendent of Schools a general supervision of all the working children of the community. Mr. Frank Dyer, who was

then Superintendent of Schools, was in thorough sympathy with the idea, and readily gave Miss Campbell and Mr. Clopper control of the child labor division of his office.

In July, 1910, Professor B. B. Breese, of the University of Cincinnati, agreed to undertake the psychological portion of the investigation. In September, 1910, the industrial part of it was given to Mr. Roger L. Conant who was placed in charge of the office which issued the working papers. He at once began the reform of the system of issuing certificates, and of recording changes of positions; and experimented with industrial schedules for the special investigation.

In March, 1911, I (Mrs. Woolley) became Director of the entire investigation, including its social and industrial phases. Mr. Breese's connection with the laboratory ended at this time.

The psychological tests of children had been begun about two weeks before I took charge. Two graduate students from Mr. Breese's laboratory had given the tests, all of which were selected from Whipple's manual. I found that the two students who were then testing children had never themselves performed the series of tests as subjects, and had come to no agreement as to the details of the method of administering tests, or of evaluating results. Accordingly I discarded all their records up to that time, and spent the first five weeks in working out with them and with Mr. William Spencer who was added to the force at this time, the details as to the form of test to be used, the method of administering the test, and the method of dealing with results. We worked by experimenting on one another, and discussing possible variations until we came to an agreement as to the best method to try with the children. Since the series of tests was considerably changed after this time and I wish to be sure that I am giving credit where credit is due, I think it best to take the space to state just what the original series installed by Mr. Breese was, and how and why it was changed.

The original schedule contained the following measurements, not all of which were applied by the students who used it:

Height—Standing, Sitting.

Weight. Diameters of skull—Length, Width.

Vital capacity. Grip—Right hand, Left hand.
Endurance of grip (16 trials with each hand).
Accuracy of movement (Target test Whipple No. 11)—
Right hand, Left hand.
Steadiness—Right hand, Left hand (not used).
Visual acuity—Right eye, Left eye.
Auditory acuity—Right ear, Left ear (not used).
Cancellation test (marking a's).
Dot counting.
Association—Part-Whole, (not used)
Opposites.
Rote memory—Five cards—9 place digits,
Five Cards—10 place digits.
Memory for related words (not used).
Completion of sentences (25 sentences).

Of the original list, the following tests were dropped or modified after I took charge.

Diameters of the skull.—Dropped because I thought the measurements difficult to make with precision and of doubtful interpretation.

Endurance of grip.—Dropped. We tried for some time to arrange this test so that the time intervals could be kept constant, short enough to insure fatigue effects, and yet allow for accurate readings, but we did not succeed. Accordingly the test was dropped, and the tapping test substituted for it.

Accuracy of movement (Target test Whipple No. 11).—Dropped, because the time consumed in evaluating it was prohibitive. As a form of eye-hand coördination, the card sorting was added in its place.

Steadiness of the hand.—Standarized and retained. It had not been used because the students did not know what method to employ.

Auditory acuity.—After trying the Lehman Acoumeter (Whipple test 18b) and finding it unusable under our very unsatisfactory conditions with regard to noise, we adopted the very rough test of the distance at which the tick of a stop-watch can be heard. The results have been used only to indicate abnormalities, not to compare keenness of hearing.

Dot counting.—Dropped, because in trying it with adults, mere differences of vision seemed to modify it seriously. Of two intelligent adults neither of whom was conscious of difficulty with vision, one was able to look at the group of dots steadily without having them appear blurred and confused, while another could not hold them distinct long enough to count even a small part of them. We were convinced that the differences in these cases were primarily visual, and had little or nothing to do with attention. Since our tests of vision were not of a nature to detect differences of this type, we thought the test an undesirable one to use as a measure of attention.

The Part-Whole Association test.—Dropped. We tried the test with a limited series of children, but found it unsatisfactory, partly because there was no way of limiting the "wholeness." A door may be part of a room, a house, a city, a state, or the universe. This difficulty seemed to puzzle the children and it makes the test a far less definitely controlled type of association than the opposites, and much more difficult to evaluate.

Rote memory.—Modified and retained. Nine- and ten-place series of digits, which the students had been using, are too far above the capacity of most fourteen-year-old children to serve well as a measure of their ability. We finally adopted a set of two seven-place, two eight-place and two nine-place cards of digits and found the test none too easy in that form. We also tried nonsense syllables as material for rote memory, but later dropped them chiefly for the sake of shortening the time of the tests.

Memory for related words.—Dropped. We found it impossible to get several lists of related words of equal difficulty, without spending more time in standardizing them than we could well afford.

Completion of sentences.—Modified and retained. We shortened the test from twenty-five sentences, which the students had been giving, to thirteen (one page of the printed blanks furnished). We also devised a system of evaluating the test, which is reported below.

Beside the tapping test, and the card sorting, we also added the

substitution test, the various form board tests, the puzzle-box test and the cause and effect.

4. Office Force

In closing this account of the history of the investigation, I wish to give a list of the regular workers in the office, aside from merely clerical assistants. I have placed them approximately in order of appointment, and have indicated which ones were part-time workers. In the case of those no longer connected with the office, I have indicated the length of service.

Mr. Roger L. Conant (Columbia), 2 years.

Mrs. Helen T. Woolley (University of Chicago).

Miss Ruth Levi (Mrs. Horace Wolf) (Volunteer), University of Cincinnati), 1 year, part-time.

Mr. L. Lurie (University of Cincinnati), 4 months, part-time.

Mr. William A. Spencer (Northwestern), 2 years.

Miss Louise Boswell (Wellesley), part-time.

Miss Annis Alden.

Mrs. Charlotte Rust Fischer (University of Chicago), part-time.

Miss Rose Rankins (Mrs. H. O. Sluss) (The Western), 1 year.

Mr. E. S. Jones (Oberlin and University of Chicago).

Miss Frances A. Foster (The Western).

Miss Olive MacMillan (University of Cincinnati), 8 months.

Miss Mary Louise Thomas (University of Cincinnati).

Mr. Conant and Miss Alden have given their time to the work certificate office. Mr. Conant also made industrial investigations and Miss Alden has done some placement work.

Miss Boswell has been concerned only with the home visiting. She has had some assistance from Miss Rankins, and Miss Foster.

Miss Levi, Mr. Lurie, Mr. Spencer, Mrs. Fischer, Miss Rankins, Miss Foster and Miss Thomas have given most of their time to the psychological laboratory.

Mr. Jones has divided his time between the laboratory and

industrial investigation, and has acted as director in the absence of the director.

Miss MacMillan has divided her time between industrial statistics and laboratory work.

5. Absence of Reference to Other Investigations

No attempt has been made at this time to compare the findings of this series of tests with those of other investigators. Since there is still the entire series of school children at fourteen and at fifteen to be reported, it seemed wiser to wait until all the facts are in, before trying to sum up the available comparative material. The literature with regard to many of the tests, up to the time of the publication of Whipple's Manual, can be found there.

6. Acknowledgments

The money which has supported the office, has been contributed by a small group of men. Mr. J. G. Schmidlapp has borne half the expense in the name of the Schmidlapp Bureau. The other contributors are Mrs. Thomas J. Emery, and Messrs. W. H. Alms, L. A. Ault, Edward Senior, John B. Scarborough, Sidney Pritz, James N. Gamble, Harry Levy and Omer T. Glenn.

It is also a pleasure to acknowledge our indebtedness to the employers of children in Cincinnati, and to its Continuation Schools, for the coöperation which made the retesting of working children possible. Most employers sent them back to the office for retesting without any objection when the matter was explained to them. Very few of the children who were paid by the week, were docked for loss of time. The piece workers, and time workers who were docked, were paid by the office. Carfare was supplied to children who needed it. While our obligations to the children for their effort in returning for the tests is great, we are glad to feel that it is not of a financial nature.

It is scarcely suitable to express our gratitude to Mr. Randall J. Condon, our present Superintendent of Schools, as an acknowledgment of assistance, since the work has gone on as part of his office régime, and he is rather to be regarded as one of the chief forces concerned in it.

CHAPTER II

LABORATORY AND STATISTICAL METHODS

(1) The Children Tested

a. Selection—The laboratory in which the children were measured and tested has from the first been located next to the work-certificate office. Our plan was to test as many of the children who came in to get certificates as our laboratory force would permit. Since at many times of the year there were more children than we could test, it became necessary to make some selection of individuals. We, therefore, decided to make our series somewhat more homogeneous by limiting it to native-born[1] white children who when tested, were fourteen years of age. In Cincinnati, the number of foreign-born, and of colored children among the applicants for work-certificates is negligibly small. At the time when our first tests were made, more than three-fourths of the applicants were fourteen years of age. Even with these limitations, therefore, we can regard our list of tested children as representative of the whole group. We did not ourselves know how many children from public and parochial schools, or from the various school grades we were testing until our series was almost complete. We then found that the distribution of our tested children between the two types of school and throughout the four school grades was very similar to that of the total group of working children (see Charting Childhood in Cincinnati, *The Survey,* Aug. 9, 1913).

b. Numbers—Although over eight hundred working children were tested in the fourteen-year series, only 753 of them appear in the summary presented. When we first began work, we neglected to ask the children how long they had been out of school. Since our compulsory education law required them to be in school until sixteen years of age, unless they had taken out working papers, we supposed that we could take it for granted that

[1] A large majority of them were of German parentage or ancestry.

children who came in for working papers at fourteen, had just left school. We discovered, however, that a number of parochial school children had been allowed to stay out of school for a year, or even two years, before they were fourteen. We then decided to exclude from our list children who had been out of school six months or more before being tested, and to accept none after that time who had been out of school more than three months before coming to the office. We were obliged on this basis to omit from the early part of the series 47 children from parochial schools. There were a few children tested at the end of the fourteen-year series whose records are not included in this summary because they were not complete at the time the summary sheets were made up. There were not enough of them (24 in all) to change the trend of the results, and the additional numbers did not add enough to the series to repay us for the great labor of changing the tables in order to include them.

In working out correlations of tests, however, or correlations of tests with industrial records, these individuals will be included. Some of them were retested at fifteen years and are included in the tables for fifteen-year working children.

There are 679 children who were retested at fifteen, and who appear in the tables of results for fifteen-year working children. The distribution of the children with regard to type of school and school grade is given in Section 1d of this chapter.

c. Age at first and second tests—Although the children were all fourteen years of age when first tested (i.e. below the fifteenth birthday, and at or above the fourteenth) it seemed worth while to make out a table showing how many months over fourteen they were, and whether there were any significant differences in this respect among the various groups represented. The following table presents the results. (Table 1.) They are summed up by grades in graph 1a for the boys and graph 1b for the girls. The graphs show a small positive correlation with school grades. In the case of the boys it is fairly regular, though small. In that of the girls, the somewhat greater age of the eighth grade girls is the only significant fact. Graph 1c, shows that the parochial school group is a little younger than the public.

The boys as a whole are a little younger than the girls—a difference which is due to the fact that the parochial school boys are the youngest group of all. All the age differences, however, are small in amount. In fact, the two boys' groups—which show the widest differences—have a median age just one month apart, and a difference of less than two months in the seventy-five percentiles.

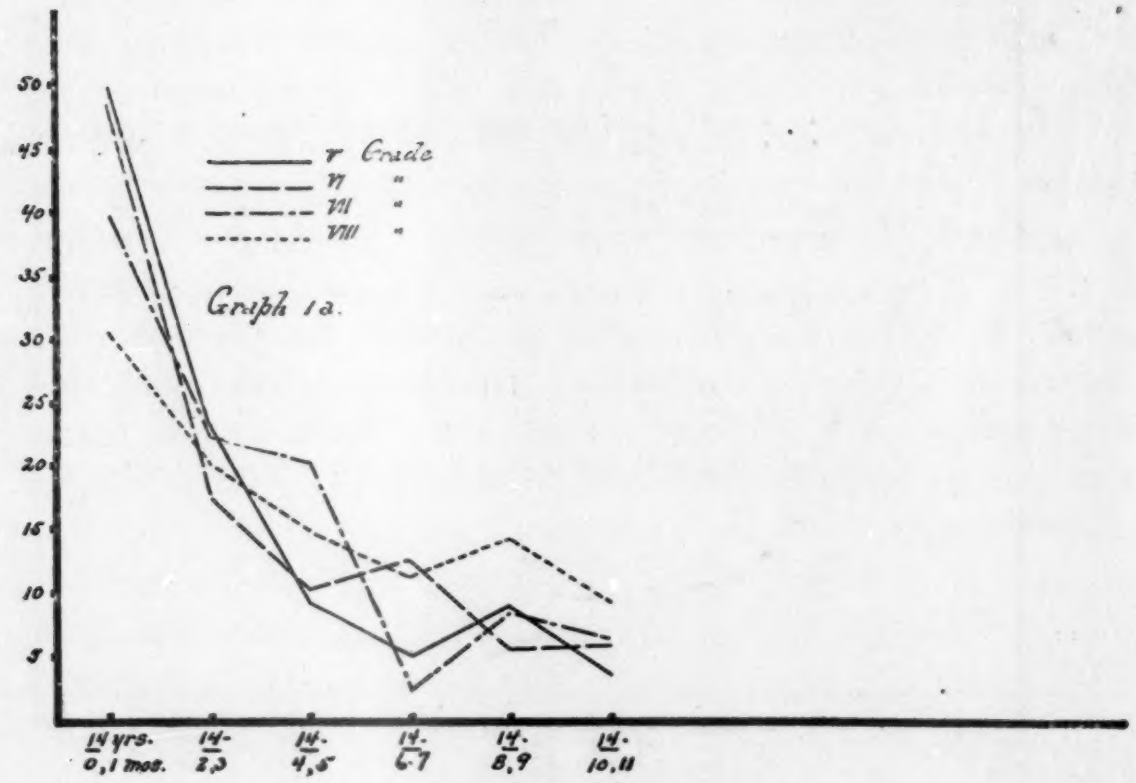
In retesting the children at fifteen years, it would of course have been ideal to make the interval exact, but we knew that would be impossible. We found that only a negligibly small number of them happened into the office to change their positions at approximately a year after the first test. It was necessary to make an effort, either through the child's employer, or through the Continuation School, to have him sent to the office for the second test. To look up each record, communicate with the proper authority, and locate the child in case he had slipped through our fingers and taken illegal employment, was a large task. In making the appointments, the convenience of the child and the employer had to be considered. To allow for these more or less time-consuming operations, we decided on a limit of two months before or after the end of the year. We began our efforts to get the children about two months before the end of the year, and kept working on difficult ones until two months after the year closed. The majority of the children were tested within a month of the end of the year.

d. Type of school and grade—Most of the children had received all of their school training in but one kind of school—public or parochial. There was a fair sized minority, however, who had divided their time between the two. In these cases, the child was classified under the kind of school in which he had spent the greatest number of years, regardless of whether it was also the last one attended.

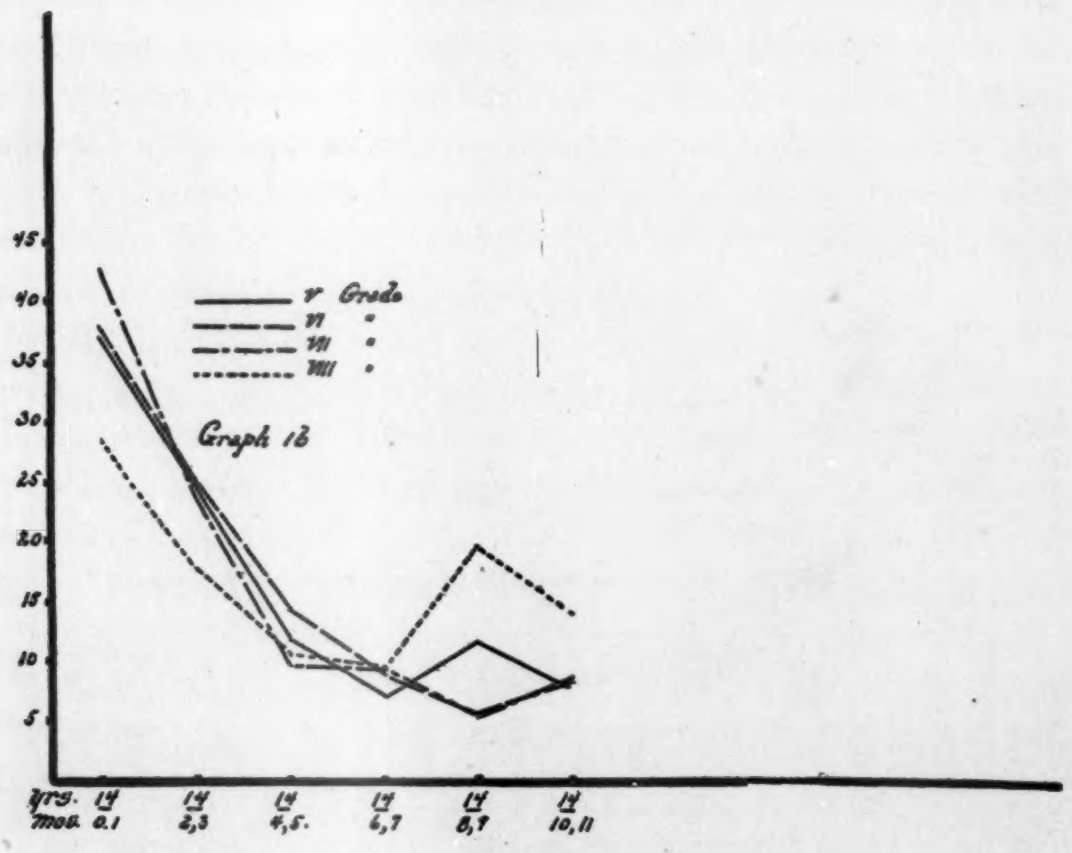
According to the child labor law of Ohio, children were not allowed to go to work at fourteen years of age unless they had finished at least the fifth grade in school. All our records of working children, therefore, are made out in terms of the highest grade completed when the child left school. A child who had

TABLE I
Age at first test

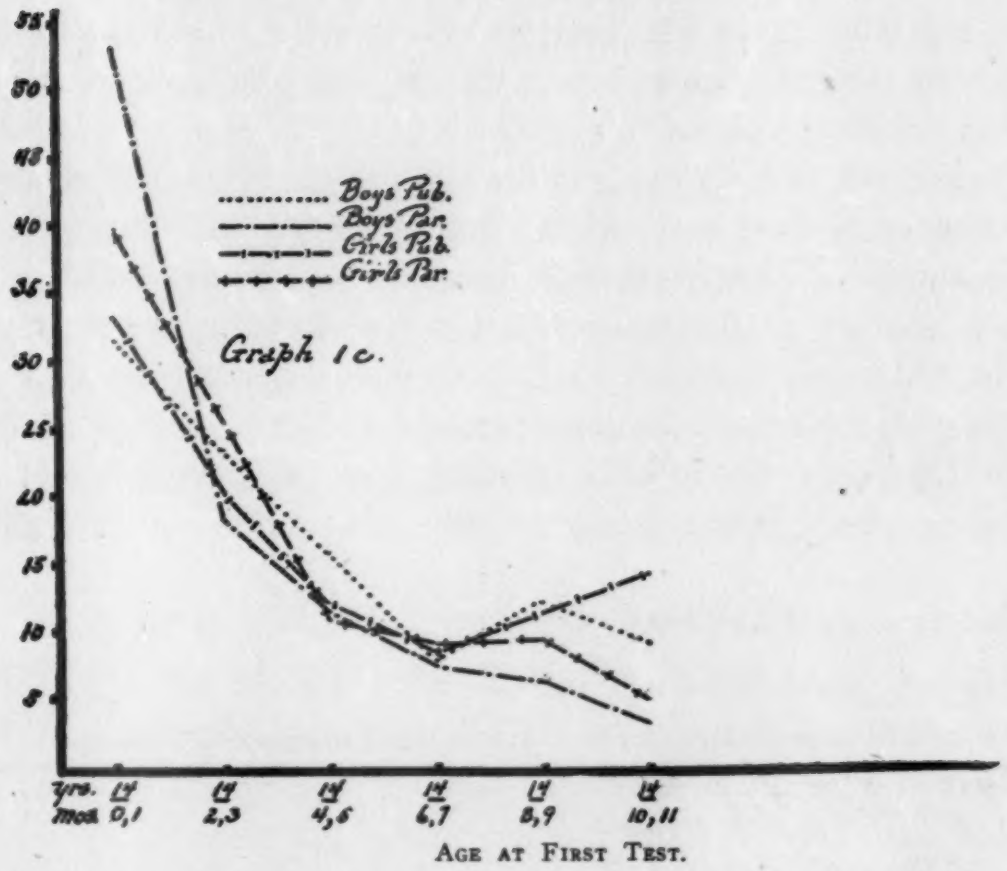
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Age	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	14 yrs. - 0 mos.	20		16		9		2				9		12		8		4			
	14 yrs. - 1 mo.	14	39.5	13	42.6	6	34.8	0		8.3		8	39.5	11	38.9	6	32.5	2		22.2	
	14 yrs. - 2 mos.	14		7		8		4				4		9		8		1			
	14 yrs. - 3 mos.	8	25.5	3	14.7	4	27.9	2		25.0		4	18.6	1	17.0	5	30.2	3		14.8	
	14 yrs. - 4 mos.	5		4		5		2	1			1		5		1		4			
	14 yrs. - 5 mos.	4	10.5	4	11.8	2	16.2	3		25.0		4	11.6	5	17.0	1	4.6	0		14.8	
	14 yrs. - 6 mos.	3		5		0		3				2		2		3		0	1		
	14 yrs. - 7 mos.	1	4.7	5	14.6	0	0.0	0		12.5		1	6.9	3	8.5	2	11.6	1		7.4	
	14 yrs. - 8 mos.	6		2		3		2				2		2		2		1			
	14 yrs. - 9 mos.	5	12.8	2	5.8	1	9.3	3		20.8		3	11.6	2	6.8	2	9.2	3	1	18.5	
	14 yrs. - 10 mos.	5		2		4		0	1			2		5		1		3	1		
	14 yrs. - 11 mos.	1	7.0	5	10.2	1	11.6	1		8.4		3	11.6	2	11.9	4	11.6	2		22.2	
	Total	86		68		43		22	2			43		59		43		24	3		
	Omitted																				
Parochial School	14 yrs. - 0 mos.	12		19		14		16				6		10		20		3	1		
	14 yrs. - 1 mo.	11	60.5	13	54.2	15	44.6	5		52.5		3	34.6	6	37.2	9	52.8	8		35.3	
	14 yrs. - 2 mos.	5		6		7		3				6		10		7		2			
	14 yrs. - 3 mos.	3	21.1	6	20.4	4	16.9	3		15.0		2	30.8	4	32.6	3	18.1	5		20.6	
	14 yrs. - 4 mos.	2		2		9		1				2		4		4		1			
	14 yrs. - 5 mos.	1	7.9	3	8.5	7	24.6	1		5.0		1	11.5	1	11.6	4	14.6	1		5.8	
	14 yrs. - 6 mos.	1		3		1		3				1		3		3		3			
	14 yrs. 7 mos.	1	5.2	3	10.2	2	4.6	1		10.0		1	7.6	1	9.3	1	7.2	1		11.7	
	14 yrs. - 8 mos.	2		1		0		1				1		1		1		5			
	14 yrs. - 9 mos.		5.3	2	5.1	5	7.7	0	2	7.5		2	11.5	1	4.6	0	1.8	0	2	20.6	
	14 yrs. - 10 mos.			1		0		2				0		1		1		1			
	14 yrs. - 11 mos.				1.7	1	1.5	1	1	10.0		1	3.8	1	4.6	2	5.4	1		5.8	
	Total	38		59		65		37	3			26		43		55		31	3		
	Omitted																				



AGE AT FIRST TEST. BOYS.



AGE AT FIRST TEST. GIRLS.



AGE AT FIRST TEST.

partly finished the sixth grade when he left, would therefore be included in the fifth grade group. In general, each group contains some individuals who had barely completed the grade, and some who had partly completed the next grade. The numbers in each grade in the two types of school, are given in the following tables.

Type of school and grade, 14-year series

	Boys						Girls					
	V	VI	VII	VIII	IX	Tot'l	V	VI	VII	VIII	IX	Tot'l
Public...	86	68	43	22	2	221	43	59	43	24	3	172
Parochial	38	59	65	37	3	202	26	43	55	31	3	158
Total ...	124	127	108	59	5	423	69	102	98	55	6	330

Type of school and grade, 15-year series

	Boys						Girls					
	V	VI	VII	VIII	IX	Tot'l	V	VI	VII	VIII	IX	Tot'l
Public...	80	62	43	22	2	209	36	53	36	20	1	146
Parochial	35	53	62	33	0	183	24	37	51	26	3	141
Total....	115	115	105	55	2	392	60	90	87	46	4	287

The striking difference in the distribution of children through the grades in the two types of school is characteristic of the entire

group of working children every year and has been discussed elsewhere (see the *Survey,* Aug. 9, 1913, also *The Elementary School Teacher,* Vol. XIV, p. 68).

The number of individuals in the ninth grade is so small that in the summaries they have always been included with the eighth grade children. Their records have been indicated separately merely to show that they have not served to raise the level of the eighth grade results. In fact they are scarcely up to the eighth grade standard in many cases—a fact which probably means that only the inferior ninth grade children, who were failing in school, came to our hands.

2. Methods of Experimentation

It is not our purpose at this point, to discuss the details of methods of experimentation. Each measurement and test is reported in a separate section of Chapter III, which includes a detailed description of the method used. At present, we wish rather to report the way in which methods were decided upon, and the precautions adopted to keep them uniform. It is impossible to lay too much stress on the importance of preserving uniformity when several individuals are giving the same series of tests. Absolute uniformity is of course an impossible ideal. No amount of training can reduce to a common level, elements of personality which nevertheless count for something in the outcome. In observing our various workers, we were impressed with the fact that the chief element of inequality which remained after we had done all in our power to secure uniformity, was a difference in the ability of the various workers to enlist the active coöperation of the child and stimulate him to his best effort. It is possible, however, to secure a high degree of uniformity in the actual methods used, and instructions given in administering a test.

The method to be adopted for any test was in every case decided upon after a series of trials in which the laboratory workers experimented on one another, discussed the possible variations, and decided which form was most promising, and most feasible for our purpose. After we had reached an agree-

ment about the details, the directions for giving the test were reduced to writing and the Director served as subject for every laboratory assistant until she felt sure that each one had mastered the method, and reduced the performance of the test to a fairly automatic state. All new assistants are trained in the same way when taken into the laboratory. The Director also kept a supervision of the work of each assistant, calling attention to any variations of method which crept into the procedure. We feel therefore that we can claim for the series of tests a higher degree of uniformity of method than is often secured when several different individuals participate in administering the tests.

The order in which the tests were given was not an absolutely fixed one, but some general rules with regard to sequence were carefully observed. The sentence test, in which we desired to have the child unconscious that he was being timed, was given very early in the series, before the idea of speed had been suggested by other tests. The mental and physical tests were alternated in such a way as to avoid fatigue as much as possible. The tapping test, and those for steadiness and strength of the hand were distributed through the series sufficiently to allow ample time for recovery. Tests involving a continuous strain of attention and writing—such as the sentences, substitution, cancellation, and opposites, were interspersed with physical measurements, or with the form-board and puzzle-box tests in which a manual element of a very different type from writing was required. The entire series including industrial records required from an hour and a quarter to two hours' time.

3. Methods of Evaluation

The difficulty of securing uniformity and accuracy in the evaluation of the tests proved to be almost as great as in the case of laboratory methods. For any test for which there were various possible ways of evaluating results—such as the memory test—the method to be adopted was made the subject of consultation, and was reduced to writing when decided upon. It proved very difficult, however, in cases where the rules for evaluation were at

all complicated, as they are in the memory test, and in the sentence test, to get a series of statements which were absolutely unequivocal. Moreover, some assistants who performed the tests very satisfactorily, seemed incapable of being perfectly accurate in their evaluations. The result was that almost all the evaluations of the early part of the fourteen-year series had to be repeated. Mrs. Fischer, who proved to be the most accurate person in the laboratory, was made the final authority on all questions of evaluation. She reëvaluated the early tests, reviewed the evaluations of each new worker until mistakes were practically eliminated—or else the individual was eliminated as an evaluator—and she also decided any new questions with regard to evaluation which arose. We found it impossible to secure constancy of method between two individuals in counting the number of ideas on the sentence page. Accordingly, Mrs. Fischer herself evaluated ideas in every sentence test from beginning to end of the series.

4. Summarizing Series of Results

a. Rough sheets—In dealing with so large a mass of material, it did not seem wise to attempt to make summaries directly from the cards. Sorting such a number of cards, or even handling them separately for each summary seemed a very lengthy process. Moreover, correcting errors, if any were made, would be as time consuming a process as making the original summary. Accordingly all the measurements to be summarized were copied from the cards on large rough sheets. The space across three 24-inch sheets was required to provide a column for each measurement in the psychological series and for the height, weight and vital capacity of the physical series. A separate set of rough sheets was used for each sex. The children's records were entered on the sheets in chronological order. The number of the working certificate was used to identify the child in the series of working children. The school children were numbered chronologically as they were tested. Each child's record, then, occupied a given line across the three large sheets, while all the measurements of any one phase of a test—for instance, the index of

card sorting—occupied a given column down the sheets. Each set of three sheets contained the records of fifty individuals. To record the entire series of fourteen-year-old boys, then, required nine such sets of three sheets each.

b. Key sheet and summary sheets—We wished to keep separate records for the sexes, for the public and parochial schools, and for the various school grades from fifth to ninth,—a plan which made twenty groups into which the total series of results had to be divided. It also seemed to us desirable,—at least for the first series of results,—to make a chronological division in order to determine whether or not communication among the children was playing any part in the results. The summaries of the fourteen-year series are therefore also divided into four chronological divisions. In order to make so complex a summary accurate, and also capable of verification, we adopted the following method. We first made out what we called a Key Sheet. It was a twenty-four-inch sheet, divided first into halves, one for public school children, and one for parochial school children. Each half was then divided again for boys and girls. The page was then subdivided across its other dimension into five divisions for the five grades. Each one of the twenty spaces thus obtained was then divided into four parts, representing four chronological subdivisions. In each of these spaces were placed the identification numbers of all the children belonging in the group indicated.

When a summary of any particular measurement was to be made—such as height—we first ruled a large sheet called a summary sheet on which each of the spaces of the key sheet had representation. We then decided by looking over the column of measurements of height on the rough sheets, what the limits of the series were, about where the greatest frequencies came, and what subdivisions it would be wise to make. Having decided on the number of steps into which to divide the entire range of the measure, we then ruled the summary sheet in such a way that each of its original spaces was divided into the requisite number of parts. We then proceeded as follows: One of us—usually the Director,—took the Key Sheet and the rough

sheets. The other—usually Mrs. Fischer—took the Summary Sheet. The group to be summarized—for instance, public school boys, fifth grade, first chronological division—was decided upon, and the space for that group located on the Summary Sheet. The person who had the Key and rough sheets then took the first number of that group from the Key Sheet, located it on the rough sheet, and read off the height of that individual. The one with the Summary Sheet found the proper space in which to record an individual of that height, and the other then gave the child's number, which was recorded in the proper space. As each group was completed the total for the group was verified and any omissions at once corrected. Any record which for any reason had been omitted, appeared on the summary sheet in pencil instead of ink. The few records which were found above or below the limits represented in the summary sheet, were written out in full. Every individual is thus accounted for on each summary sheet, and his record, if any doubt arises, can be verified at any time. Furthermore, rough correlations among tests, and rough comparisons of one individual's records from year to year can be obtained directly from the summary sheets.

c. Tables—The tables in each case are obtained directly from the summary sheets by merely counting the individuals entered at each step. The chronological subdivisions do not appear in the tables, because they proved to be of no practical importance. The subdivisions of the tables are in most cases not as fine as those of the summary sheets. The larger subdivisions proved to be easier to interpret. The exact limits included within each step of the tables are carefully indicated in the margin.

While each table for both the fourteen- and fifteen-year series accounts for the entire number of children tested (753 at fourteen years, and 679 at fifteen years) some of them do so by including a large number of omissions. In the fourteen-year series, these tables represent tests which were introduced into the series after work was begun, so that the first children tested did not receive them. The opposites test is an exception to this statement. It was discontinued for some time because we thought it was being modified by communication among the children.

Smaller numbers of omissions are sometimes due to the fact that pieces of apparatus were out of order, and required a little time for repair. Occasionally, when the children were in haste, some tests had to be omitted. Then again, a stop-watch sometimes failed to work, or broke down in the middle of a test, so that the time was lost, and occasionally tests were forgotten by the experimenter.

d. Percentiles—The percentiles present a rough measure of the whole group, with no distinctions but that of sex. These were obtained directly from the tables by discarding all grade and school subdivisions, and merely counting the number of individuals of each sex found at each step in the tables. In estimating the exact point at which the percentiles fall, the distribution of cases within the step in question has been regarded as even. Percentiles have been estimated, for purposes of comparison, even in those cases in which they obviously do not coincide with any actual measure of the series.

e. Graphs—The graphs are designed to present comparisons of the school grades, from the fifth to the eighth, of the two kinds of schools, and of the sexes. Since the number of individuals represented in the various grades, and in the two kinds of schools differs considerably (see Chapter II, Section 1d), the only way of making fair comparisons was to reduce each group to terms of the percentage of individuals found at each step of the measure in question. The original tables are made out with percentages figured for each step of the table. But in order to get graphs which were simple enough in form to indicate the trend of the series clearly, it was found necessary in most cases to combine the results into larger groups. The percentages given in the printed tables, are those actually used in making up the graphs, and will be found to correspond in each case to the steps on the abscissas of the graphs.

In making out graphs to show the presence or absence of grade correlations, the method used was to average the percentages for the two kinds of schools at each step of the tables. We followed this method rather than that of counting each individual within the combined grade group as one, for this reason.

In the public school group, the largest number of individuals is found in the lower grades, while in the parochial school group, the largest number is found in the upper grades (see Section 1d). On the whole, however, the public school children have better records than the parochial school children. Combining the two groups on the basis of mere numbers of individuals would therefore tend to obscure the grade correlations. It would have the effect of raising the standard of the lower grades, and lowering that of the higher grades. By figuring the percentages for the two types of school separately, and then basing the graphs on an arithmetical mean between the two sets of percentages, this source of confusion is eliminated. In order to verify our graphs from the tables, therefore, it is only necessary to take an arithmetical mean between the percentages for corresponding points in the public and parochial sections, and find that the percentage thus obtained is the one used in constructing the graph.

The graphs for the entire group of public school boys, parochial school boys, etc., were obtained from the tables, by taking an average of the percentages for the four grades at each step of the table.

In order to make the graphs easy to interpret, we adopted a different form of line to represent each factor dealt with. In the graphs showing grade correlations, the following symbols were adopted:

Grade V ———

Grade VI — — —

Grade VII — - — - — -

Grade VIII - - - - - - - - -

In the graphs for comparisons of sex and school, the symbols were as follows:

Boys public school . . . . . .

Boys parochial school — · — · — · — · — · — ·

Girls public school — | — | — | — | — | — |

Girls parochial school —+—+—+—+—+—

CHAPTER III

Section I—Height

Table 2.—Height 14 years. Table 3.—Height 15 years

Material—A measuring rod mounted on a standard. The rod reading centimeters on one side and inches on the other, furnished with a sliding arm. A vernier measure reading in centimeters.

Method of taking the measurement—The height was taken without removing the shoes, but in each case the height of the heel was measured with the vernier, and subtracted from the total height before it was recorded. Girls who wore braids or combs on the top of the head were required to remove them while the measurements were being taken. Each child was asked to stand on the platform of the instrument as straight as possible with his back against the rod. When the position was satisfactory, the sliding arm was lowered until it touched the top of the head. The reading, minus the height of the heel, was recorded in centimeters. The height sitting was taken with the same apparatus. The child was directed to sit on the platform of the instrument, move back against the rod, and sit up as straight as possible. The sliding arm was then lowered until it touched the top of the head, and the reading was recorded in centimeters.

Method of dealing with results—So far, no use has been made of the height sitting. The height standing has been summed up to show the differences in sex, grade, and school which are reported in the following section.

RESULTS

	Boys				Girls			
	14 years		15 years		14 years		15 years	
	Centimeters	Inches	Centimeters	Inches	Centimeters	Inches	Centimeters	Inches
25 perc.	146.3	57.6	152.2	59.9	150.5	59.25	153.6	60.5
50 perc.	151.3	59.6	158.3	62.3	155.0	61.0	157.5	62.0
75 perc.	156.7	61.7	162.8	64.1	159.0	62.6	161.6	63.6
Q	5.2		5.3		4.25		4.0	
Limits—								
Lower	131	51.6	135	53.15	137.2	54.0	142	55.9
Upper	171.0	67.3	178.3	70.2	170	66.9	174.7	68.8

Height in centimeters and inches, percentiles and limits

Correlation with school grade.

Graph 2a—Boys, 14 years.

Graph 2b—Girls, 14 years.

Graph 3a—Boys, 15 years.

Graph 3b—Girls, 15 years.

A positive correlation with school grade exists both at fourteen and fifteen years. Both boys and girls in the lower grades are shorter than those in the higher grades. In the case of the boys the correlation is marked at both ages, while in that of the girls it is much more evident at fourteen than at fifteen.

The graphs for age (1a and 1b—Chapter II) show that there is a positive age correlation with school grade, based on the number of months over fourteen. The correlation is small, but regular in the case of the boys. In that of the girls, the fact that the eighth grade group is a month or two older than the others is the only significant point. While part of the height correlation, therefore, may be due to age, the age difference is scarcely sufficient to account for it all.

Comparisons of sex, and of school.

Graph 2c—14 years.

Graph 3c—15 years.

Sex—Both the percentiles and the graphs show that at fourteen the girls are decidedly taller than the boys. The difference indicated by the percentiles is about four centimeters. The percentiles and graphs also show less variability in height among the girls. At fifteen years the boys have caught up with the girls in height—or perhaps surpassed them a bit, but they still display more variability.

School—Both at fourteen and at fifteen, the public school boys and girls are somewhat taller than those from the parochial school. Since the public school group is a trifle older (a month to six weeks on the average) the factor of age may play a part in the difference of height.

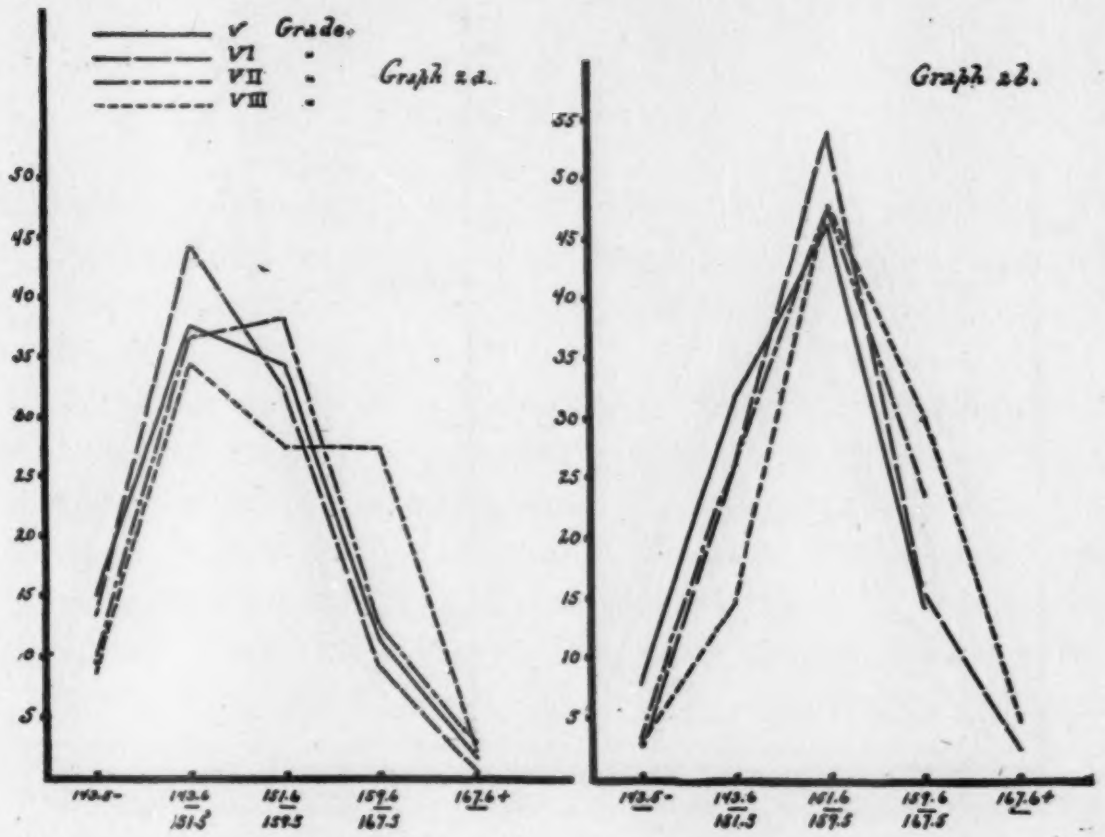
Age—Both sexes gain in height from fourteen to fifteen years, but while the boys as a group gain about 6.5 cm., the girls gain only about 2.75 cm. Although at fourteen the girls are decidedly taller than the boys, at fifteen there is very little difference in height.

TABLE 2
Height—14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Height in cms.	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	135.5—	0		0		0		0	1			0		0		0		0			
	135.6 - 139.5	1		3		0		0				0		0		0		0			
	139.6 - 143.5	9	11.7	5	11.7	2	4.7	2		12.5		5	11.6	0	0.	1	2.3	0		0.	
	143.6 - 147.5	16		14		7		5				5		4		4		1	1		
	147.6 - 151.5	19	40.7	15	42.7	8	34.9	3		33.3		9	32.5	10	23.8	6	23.3	1		11.1	
	151.6 - 155.5	16		12		10		5				7		14		12		9	1		
	155.6 - 159.5	9	29.1	11	33.8	9	44.2	1		25.0		8	34.9	18	54.2	10	51.2	3		48.1	
	159.6 - 163.5	10		5		4		6				6		7		8		4			
	163.6 - 167.5	3	15.1	3	11.7	1	11.6	0		25.0		3	21.0	3	17.0	2	23.2	5	1	37.0	
	167.6 - 171.5	3	3.5	0	0	2	4.7	0	1	4.2		0	0.	3	5.1	0	0.	1		3.7	
	Total	86		68		43		22	2			43		59		43		24	3		
	Omitted	0		0		0		0	0			0		0		0		0	0		
Parochial School	135.5—	1		1		1		0				0		0		0		0			
	135.6 - 139.5	1		5		2		0				0		1		1		1			
	139.6 - 143.5	5	18.4	3	15.3	6	13.8	2		5.0		1	3.8	1	4.6	1	3.6	1		5.8	
	143.6 - 147.5	8		13		10		5	1			2		2		8		1			
	147.6 - 151.5	5	34.2	14	45.7	15	38.5	8		35.0		6	30.8	10	27.9	8	29.0	4	1	17.6	
	151.6 - 155.5	13		11		11		8				10		10		12		3	1		
	155.6 - 159.5	2	39.5	7	30.5	10	32.3	4		30.0		5	57.7	13	53.5	12	43 6	11	1	47.1	
	159.6 - 163.5	2		2		5		8	1			2	7.7	5		11		6			
	163.6 - 167.5	1	7.9	2	6.8	4	13.8	2	1	30.0		0		1	13.9	2	23.6	2		23.5	
	167.6 - 171.5	0	0.	1	1.7	1	1.5	0		0.0		0		0	0.	0	0.	2		5.9	
	Total	38		59		65		37	3			26		43		55		31	3		
	Omitted	0		0		0		0	0			0		0		0		0	0		

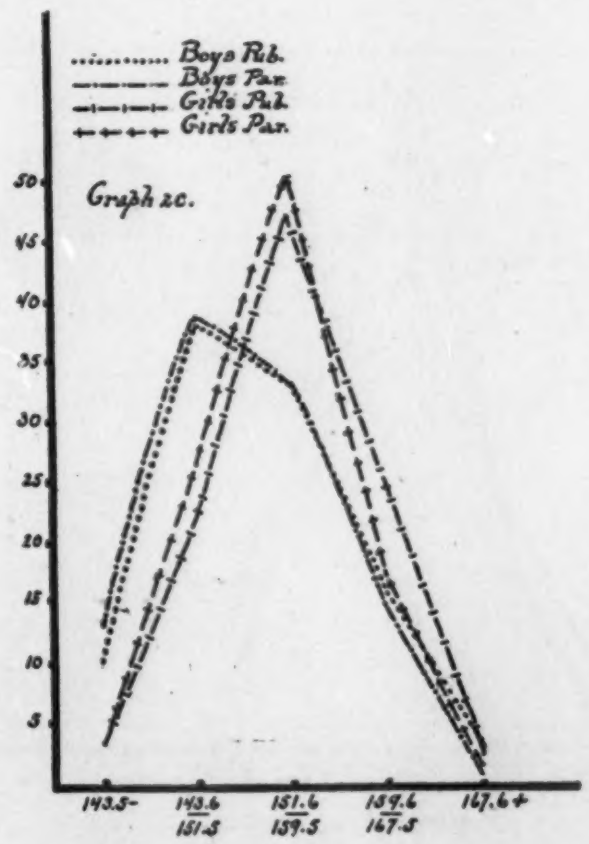
TABLE 3
Height. 15 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Height in cms.	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	135.5—	0		0		0		0	1			0		0		0		0			
	135.6 - 139.5	0		0		0		0				0		0		0		0			
	139.6 - 143.5	1	1.2	2	3.2	0	0.	0		4.2		1	2.8	0	0.	0	0.	0		0.	
	143.6 - 147.5	1		0		2		0				1		0		2		0			
	147.6 - 151.5	15	20.0	5	8.1	4	14.	1		4.2		5	16.7	7	13.2	4	16.7	1		5.	
	151.6 - 155.5	15		16		3		5				7		14		5		3			
	155.6 - 159.5	16	38.7	12	45.2	12	34.9	4		37.5		10	47.2	9	43.4	14	52.8	8		55.	
	159.6 - 163.5	13		12		10		4				8		15		6		2	1		
	163.6 - 167.5	11	30.	6	29.0	6	37.2	6		41.7		3	30.5	4	35.8	5	30.6	4		35.	
	167.6 - 171.5	6		8		4		1				1		3		0		1			
	171.6 - 175.5	1		1		2		1				0		1		0		0			
	175.6 - 179.5	1	10.	0	14.5	0	14.	0	1	12.5		0	2.8	0	7.5	0	0.	0		5.	
	Total	80		62		43		22	2			36		53		36		19	1		
	Omitted																	1			
Parochial School	135.5—	0		0		0		0				0		0		0		0			
	135.6 - 139.5	1		2		0		0				0		0		0		0			
	139.6 - 143.5	1	5.7	2	7.5	2	3.2	0		0.		0	0.	1	2.7	0	0.	1		3.4	
	143.6 - 147.5	4		2		4		1				0		1		2		0			
	147.6 - 151.5	2	17.1	8	18.9	11	24.6	4		15.1		2	8.3	5	16.2	5	14.0	3	1	13.8	
	151.6 - 155.5	6		10		8		1				8		7		10		2	1		
	155.6 - 159.5	8	40.	9	35.8	9	27.9	10		33.3		10	75.0	13	54.1	13	46.0	9	1	44.8	
	159.6 - 163.5	9		10		11		7				3		7		8		3			
	163.6 - 167.5	2	31.4	5	28.3	5	26.2	5		36.4		1	16.7	2	24.3	10	36.0	4		24.1	
	167.6 - 171.5	1		5		8		4				0		1		1		4			
	171.6 - 175.5	1		0		3		1				0		0		1		0			
	175.6 - 179.5	0	5.7	0	9.4	0	18.0	0		15.1		0	0.	0	2.7	0	4.	0		13.8	
	Total	35		53		61		33				24		37		50		26	3		
	Omitted					1										1					

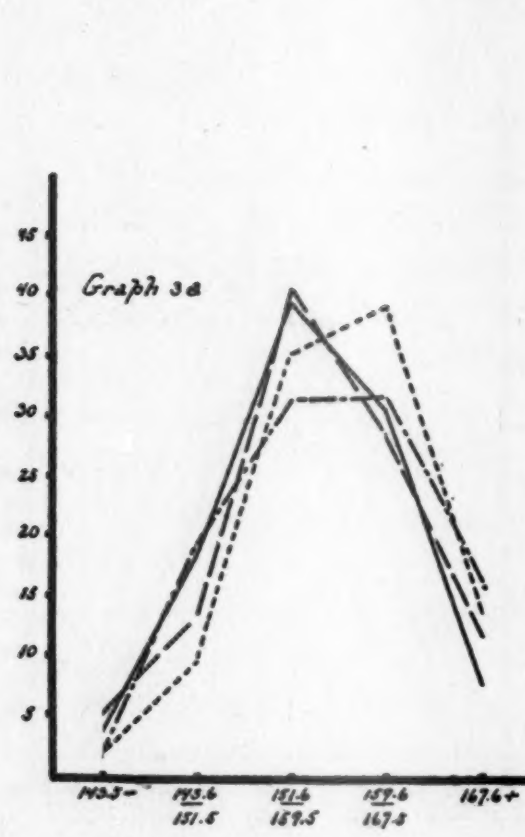


HEIGHT. 14 YEARS. BOYS.

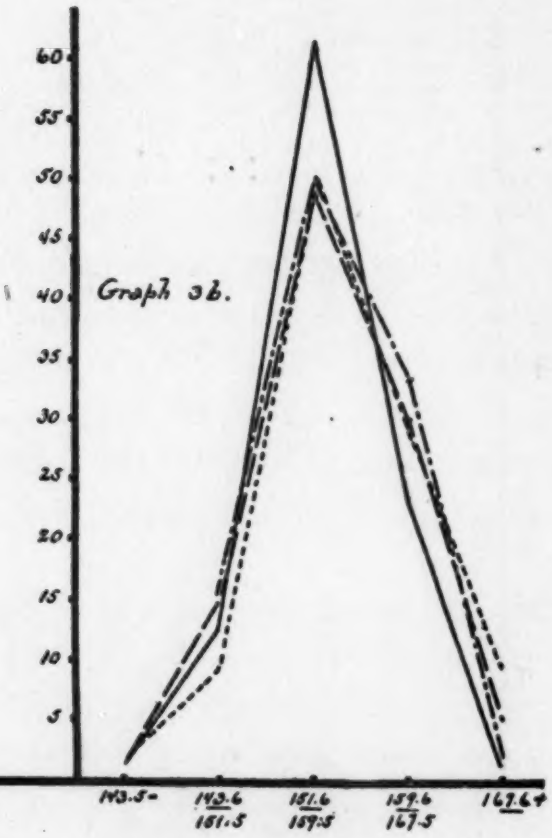
HEIGHT. 14 YEARS. GIRLS.



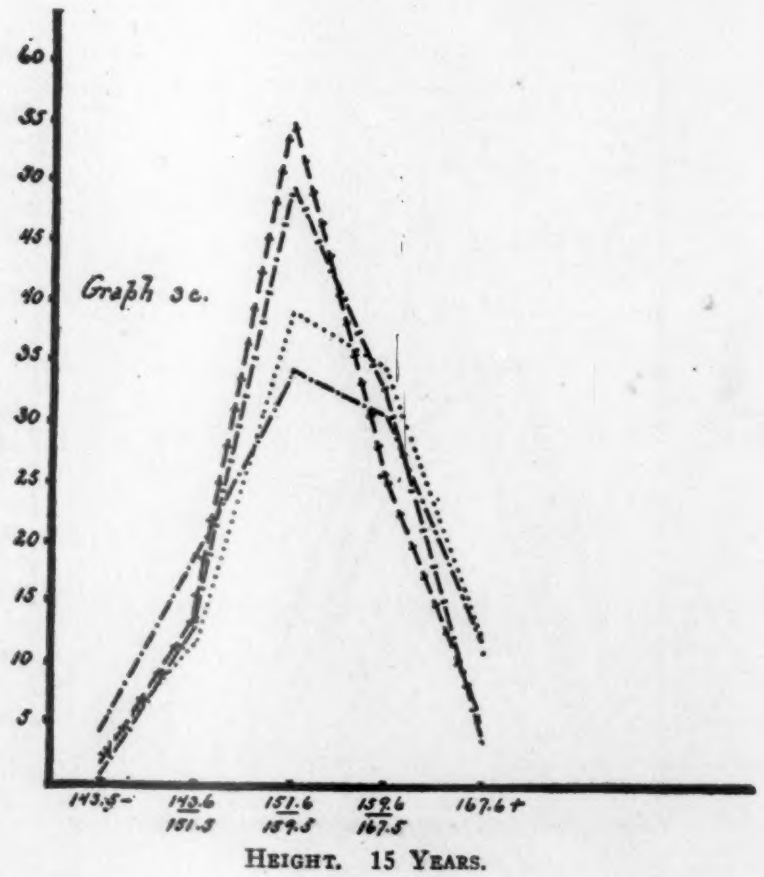
HEIGHT. 14 YEARS.



HEIGHT. 15 YEARS. BOYS.



HEIGHT. 15 YEARS. GIRLS.



HEIGHT. 15 YEARS.

Section II—Weight

Table 4—Weight, 14 years. Table 5—Weight, 15 years.

Material—A standard scale, reading kilograms on one side and pounds on the other. The scale records weights to twentieths of a kilogram.

Method of taking the measurements—Weights were taken with the children clothed. The office had no facilities for taking a stripped weight, and would scarcely have dared to face the opposition aroused by such a procedure if it had. All weights were taken without wraps, and in the case of the boys, coats were removed. Since the weights of the same individual were taken at intervals of about a year, the clothing was that of the same season each time.

Method of dealing with the results—The weights were recorded in kilograms, and summed up in the tables which appear below:

RESULTS

	Boys				Girls			
	14 years		15 years		14 years		15 years	
25 perc.	36.8	81 lbs.	41.9	92.2 lbs.	40.2	88.2 lbs	44.8	98.6 lbs.
50 perc.	40.7	89.5 lbs.	47.1	103.6 lbs.	44.9	98.8 lbs.	49.1	108.0 lbs.
75 perc.	45.3	99.7 lbs.	52.4	115.3 lbs.	49.7	109.3 lbs.	54.0	118.8 lbs.
Q	4.25		5.25		4.75		4.6	
Limits—								
Lower	26.1		29.45		29.5		34.9	
Upper	66.1		68.45		86.3		95.0	

Weight in kilograms and pounds, percentiles and limits

Correlation with school grade.

Graph 4a—Boys, 14 years.

Graph 4b—Girls, 14 years.

Graph 5a—Boys, 15 years.

Graph 5b—Girls, 15 years.

There is a rough correlation with school grade in the graphs for weight at both fourteen and fifteen years, but it is not as marked or as consistent as in the case of height. But here too,

the small differences of age (Graphs 1a and 1b) may partly account for it.

Comparisons of sex and school.

Graph 4c—14 years.

Graph 5c—15 years.

Sex—Both percentiles and graphs show that the girls are heavier than the boys at fourteen and at fifteen years. The difference in the percentiles is roughly 4 kg. at fourteen years, and 2 kg. at fifteen years. While the boys have gained on the girls in weight, during the year, they have not overtaken them as they did in height. The difference in variability between the two groups in this case is not consistent.

School—The public school children as a whole are heavier than those from the parochial school. The difference is marked for both years in the case of the girls. In the case of boys, this is scarcely perceptible at fourteen, and is small at fifteen, though the difference in age between the two groups is greatest in the case of the boys (Graph 1c).

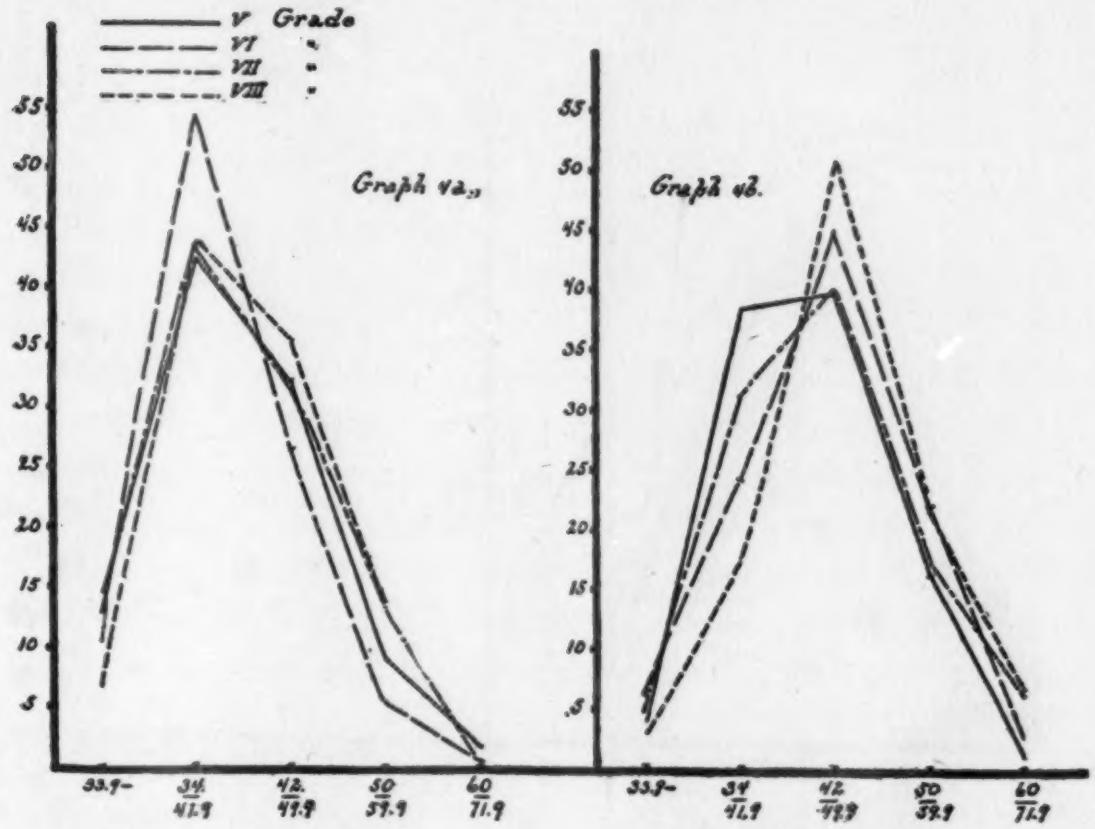
Age—Both sexes gain in weight from fourteen to fifteen years, but while the boys as a group gain about 6 kg., the girls gain only a little over four. The girls still retain the advantage in weight at fifteen years by about 2 kg., though they have lost their superiority in height.

TABLE 4
Weight. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Weight in kg.	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	29.9—	1		0		1		0				0		0		0		0			
	30 - 33.9	10	12.8	7	10.3	1	4.6	1	1	8.3		2	4.6	3	5.1	2	4.6	0	1	3.7	
	34 - 37.9	12		15		8		6				4		4		4		1			
	38 - 41.9	29	47.9	23	55.9	10	41.9	6		50.0		11	34.9	7	18.6	8	27.9	2		11.1	
	42 - 45.9	14		13		9		5				5		19		10		7	1		
	46 - 49.9	10	28.0	6	27.9	7	37.2	2		29.2		11	37.2	8	45.8	8	41.9	5	1	51.8	
	50 - 53.9	4		3		3		1	1			7		10		5		4			
	54 - 59.9	5	10.5	1	5.9	4	16.3	1		12.5		2	20.9	6	27.1	3	18.6	3		25.9	
	60 - 65.9	1		0		0		0				1		0		0		1			
	66 - 71.9	0	1.2	0	0.	0	0.	0		0.		0	2.3	2	3.4	3	7.0	1		7.4	
	Total	86		68		43		22	2			43		59		43		24	3		
	Omitted	0		0		0		0	0			0		0		0		0	0		
Parochial School	29.9—	2		3		1		0				0		1		0		0			
	30 - 33.9	4	15.8	6	15.3	10	16.9	2		5.0		1	3.8	2	7.0	3	5.4	1		2.9	
	34 - 37.9	7		11		12		6				2		4		8		4			
	38 - 41.9	7	36.8	20	52.6	17	44.6	9		37.5		9	42.3	9	30.2	11	34.5	4		23.6	
	42 - 45.9	10		12		7		10	1			3		12		12		6	2		
	46 - 49.9	4	36.8	3	25.4	10	26.1	5	1	42.5		8	42.3	7	44.2	9	38.2	8	1	50.0	
	50 - 53.9	2		1		6		4				3		5		6		5			
	54 - 59.9	1	7.9	2	5.1	1	10.8	1	1	15.0		0	11.5	2	16.3	3	16.4	1		17.6	
	60 - 65.9	1		0		1		0				0		1		2		1			
	66 - 71.9	0	2.6	1	1.7	0	1.5	0		0.		0	0.	0	2.3	1	5.4	1		5.8	
	Total	38		59		65		37	3			26		43		55		31			
	Omitted	0		0		0		0	0			0		0		0		0			

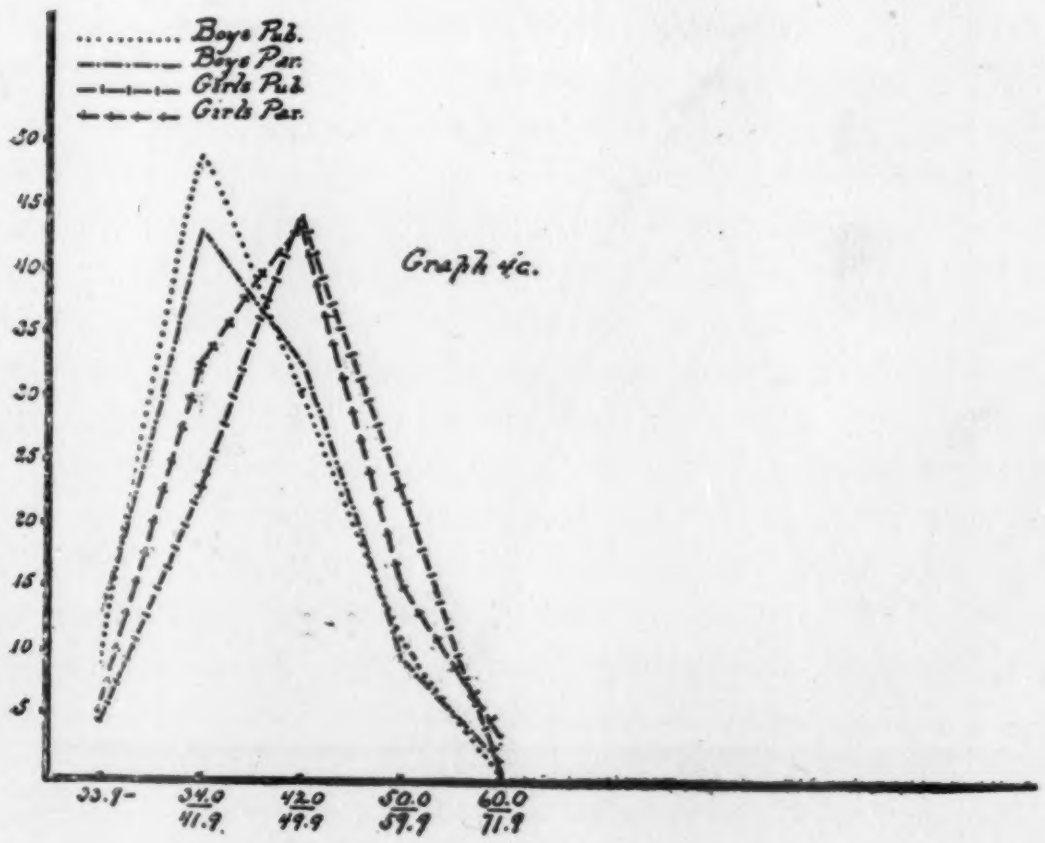
TABLE 5
Weight. 15 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Weight in kg.	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	30 - 33.9	0		0		1	2.3	0				0		0		0		0			
	34 - 37.9	7		3		0		0	1			1		1		4		0			
	38 - 41.9	18	31.2	9	19.3	4	9.3	3		16.7		5	16.7	5	11.3	2	16.7	2		10.	
	42 - 45.9	13		16		10		4				8		5		5		1			
	46 - 49.9	15	35.	13	46.8	8	41.9	9		54.2		7	41.7	16	39.6	7	33.3	5	1	35.	
	50 - 53.9	14		9		9		4				8		6		9		3			
	54 - 59.9	8	27.5	9	29.0	8	39.5	1		20.8		6	38.9	12	33.9	6	41.7	8		55.	
	60 - 65.9	4		3		2		1	1			0		6		1					
	66 - 71.9	1		0		1		0				1		0		1					
	72 - 77.9	0		0		0		0				0		1		0					
	77.9+	0	6.2	0	4.8	0	7.0	0		8.3		0	2.9	1	15.1	1	8.3				
	Total	80		62		43		22	2			36		53		36		19	1		
	Omitted																	1			
Parochial School	30 - 33.9	3	8.6	4	7.5	1	1.6	0				0		0		0		0			
	34 37.9	3		5		8		2				0		3		2		1			
	38 - 41.9	2	14.3	9	26.4	6	22.9	8		30.3		4	16.7	2	13.5	4	12.	0		3.4	
	42 - 45.9	9		11		9		2				6		8		10		5			
	46 - 49.9	7	45.7	11	41.5	12	34.4	8		30.3		6	50.	8	43.2	15	50.	7	2	48.3	
	50 - 53.9	6		7		8		5				5		8		8		7	1		
	54 - 59.9	4	28.6	5	22.6	13	34.4	5		30.3		3	33.3	4	32.4	7	30.	4		41.4	
	60 - 65.9	1		1		3		3				0		3		3		0			
	66 - 71.9	0		0		1		0				0		0		0		1			
	72 - 77.9	0		0		0		0				0		1		1		1			
	77.9+	0	2.9	0	1.9	0	6.6	0		9.1		0		0	10.8	0	8.	0		6.9	
	Total	35		53		61		33				24		37		50		26	3		
	Omitted					1										1					

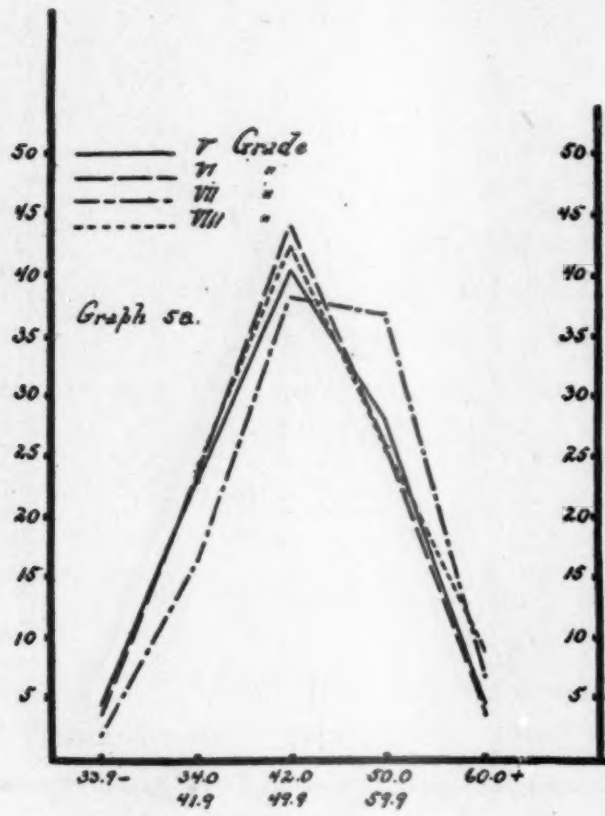


WEIGHT. 14 YEARS. BOYS.

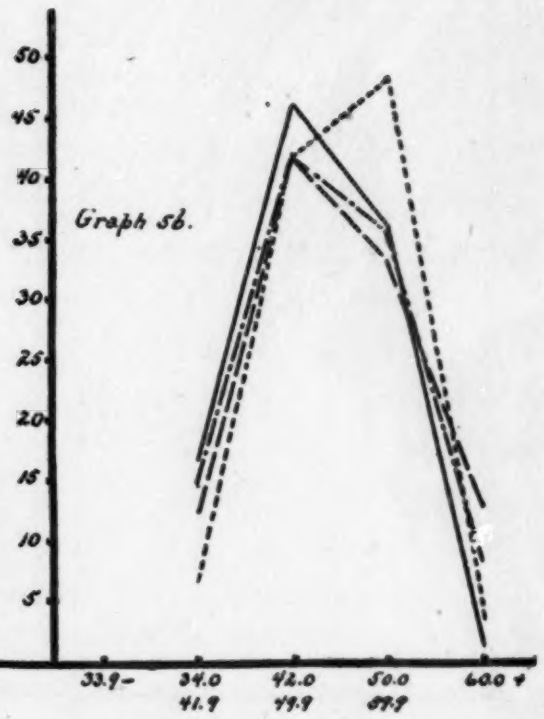
WEIGHT. 14 YEARS. GIRLS.



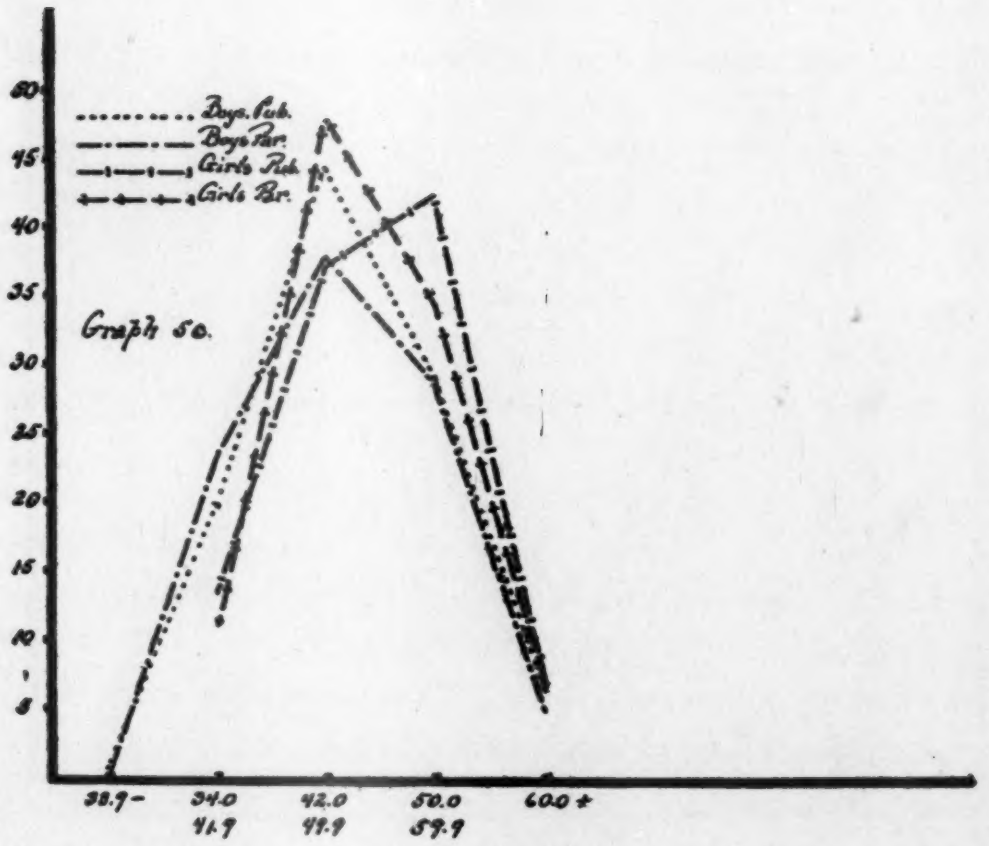
WEIGHT. 14 YEARS.



WEIGHT. 15 YEARS. BOYS.



WEIGHT. 15 YEARS. GIRLS



WEIGHT. 15 YEARS.

Section III—Visual Acuity

Table 6. Visual acuity—14 years.

Materials—A chart of Snellen test type, spectacle frame, eye shield, and two lenses.

Method of making the test—The illumination was that of daylight, with the addition of the electric lights of the ceiling. On a bright day, the electric lights added no appreciable illumination to the chart. On a dark day, the effect was perceptible, helping to keep the conditions of illumination more constant. The child was seated on a chair, facing the chart, at such a distance that when leaning against the back of the chair, his eyes were twenty feet from the chart. The distance, of course, was not exact to the inch because of differences of posture. The spectacle frames were adjusted to the child's eyes, with the experimenter standing between him and the chart. The shield was placed first over the left eye. The experimenter then called the child's attention to the chart, and asked him to read the letters of the fourth or fifth line. If he could not do so, the experimenter proceeded with the upper lines of the chart. If he read the fourth line correctly, he was asked to read the lines of smaller letters, until his limit was reached. The experimenter then tried the two lenses for myopia and hyperopia and recorded the result. The shield was then transferred to the right eye, and the left eye tested in the same way, except that the child was asked to read the lines of letters backward instead of forward.

Any child who habitually wore glasses in school, was tested with his glasses on, since what we wished to know was the degree to which the children had been handicapped by defective vision, or would be so handicapped when at work.

The test is of course a rough one, and it takes no proper account of the very important factor of astigmatism.

Method of dealing with results—The results were recorded in diopters. These are summed up roughly in Table 6. The first group contains all the children, both of whose eyes gave a result

of 1.0. In the second group are those who had one perfectly normal eye, the other one testing one-half or above. In the third group are those with one eye normal, and the other less than one-half. The remaining five groups of the table contain the children who have both eyes more or less below normal. In the fourth group, the two eyes test the same, and are one-half or above. In the fifth group the two eyes test differently, but are both of them one-half or above. In the sixth group, one eye tests more than one-half, and the other less. In the seventh group the two eyes are different, and both of them less than one-half.

There is no table of visual acuity at fifteen years. Children whose eyes were perfectly normal at fourteen, were as a rule not re-tested at fifteen. Those with defects of vision were re-tested, but the results are not significant in the form of a group summary. In dealing with individual cases, they may be of great value.

RESULTS

Table 6 shows that children with both eyes normal are somewhat more numerous in the upper grades than in the lower, while decided defects preponderate in the lower grades. The differences, however, are not as large as one might expect. They are certainly not large enough to indicate that defective vision has been a large factor in retardation.

The group of children with very defective vision is distributed through the four grades in such a way that more than the due proportion of them is found in the fifth grade, and less than the expected number in the eighth grade, while the sixth and seventh grades have about their fair share.

TABLE 6
Visual acuity. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
		No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	*Group a.	47	55.3	39	57.3	21	51.2	16		66.7		20	46.6	26	44.8	25	58.1	13	2	55.5	
	b.	14	16.5	9	13.2	4	9.8	1	1	8.3		10	23.3	10	17.2	6	14.0	6		22.2	
	c.	1	1.2	4	5.9	5	12.2	1		4.2		3	7.0	2	3.4	2	4.6	2		7.4.	
	d.	12	14.1	8	11.8	8	19.5	3	1	16.7		6	14.0	12	20.7	4	9.3	2		7.4	
	e.	3	3.5	1	1.5	1	2.4	0		0.0		1	2.3	4	6.9	1	2.3	1	1	7.4	
	f.	4	4.7	7	10.3	1	2.4	1		4.2		0	0.0	1	1.7	3	7.0				
	g.	3	3.5			0	0.0					1	2.3	2	3.4	1	2.3				
	h.	1	1.2			1	2.4					2	4.6	1	1.7	1	2.3				
		85		68		41		22	2			43		58		43		24	3		
		1		0		2		0	0			0		1		0		0	0		
Parochial School	a.	24	63.2	28	47.4	39	61.0	24	2	66.7		12	46.1	24	55.8	30	55.6	17	3	58.8	
	b.	6	15.8	19	32.2	12	18.7	4		10.3		0	0.0	9	20.9	13	24.1	7		20.6	
	c.	1	2.6	2	3.4	3	4.7	2		5.1		1	3.8	2	4.6	3	5.5	0		0.0	
	d.	6	15.8	6	10.2	4	6.2	3	1	10.3		3	11.5	2	4.6	2	3.7	5		14.7	
	e.	0	0.0	1	1.7	0	00	0		0.0		3	11.5	0	0.0	2	3.7	0		0.0	
	f.	1	2.6	0	0.0	3	4.7	1		2.6		2	7.7	3	7.0	1	1.8	0		0.0	
	g.			1	1.7	3	4.7	1		2.6		3	11.5	3	7.0	1	1.8	2		5.9	
	h.			2	3.4	0		1		2.6		2	7.7	0		2	3.7	0			
		38		59		64		36	3			26		43		54		31			
		0		0		1		1	0			0		0		1		0			

*Group a.—Both eyes normal (i. e. 1.0).
Group b.—One eye normal, one 0.5 or more.
Group c.—One eye normal, one less than 0.5.
Group d.—Both eyes defective, but same and 0.5 or over.
Group e.—Both eyes defective—different, but both 0.5 or over.
Group f.—Both eyes defective—different, one 0.5 or over; one under 0.5.
Group g.—Both eyes defective—same—both less than 0.5.
Group h.—Both eyes defective—different—both less than 0.5.

Section IV—Auditory Acuity

Table 7—Auditory acuity—14 years.

Materials—A screen, fastened perpendicularly to the center of a long blackboard, on which was a line marked off in meters and tenths of meters. A stop-watch. Cotton.

Method of making test—The child was seated facing the blackboard, with his head on the left side of the screen, so placed that his ear projected beyond the screen. The left ear was stuffed with cotton. The experimenter then instructed him as follows: "What I want you to do is to tell me every time I ask you whether or not you hear this watch tick. You hear it now, do you not? (holding it close to his right ear). Just say, 'Yes,' if you hear it, and 'No,' if you don't." The experimenter then began near the right ear, asking—"Do you hear it now?" Upon receiving the answer "yes," the watch was moved a half meter further out, and the question repeated. The watch was at frequent intervals entirely removed from the field of hearing in order to detect the tendency to guess which is so disturbing in this form of test. After being moved out by large steps until the sound was lost, it was moved in again by steps until it was undoubtedly heard, and a rough limit thus established. It was occasionally found necessary to warn a child that he was guessing at the sound before any consistent limit could be obtained. After finding a limit for the right ear, the child was asked to sit with his head on the other side of the screen, and the procedure was repeated for the left ear.

Method of dealing with results—The method is itself a very rough one,—the noise of a downtown street making an additional handicap. It was useless to base any comparison of keenness of hearing on results thus obtained. It did seem to be true, however, that defects of hearing were revealed. After making a large series of measurements, we decided that an ear which gave a limit of a meter or more under such conditions, must be considered normal. One which gave a limit of less than half a meter,

was undoubtedly abnormal, while one with a limit falling between 50 and 100 cms. was probably a little defective, though not enough so to constitute a serious handicap in most occupations. Accordingly we made up the table of results on that basis. The first division contains children with two undoubtedly normal ears. The second division contains those with one normal, and one slightly defective ear, the third, those with one normal and one decidedly defective ear; the fourth, those with two slightly defective ears, the fifth, those with one slightly defective and one decidedly defective ear, and the sixth those with two decidedly defective ears.

RESULTS

The outcome of the test for auditory defects is very much the same as that for visual defects. There is a slightly greater proportion of children with both ears normal, in the upper grades, and of children with marked defects in the lower grades. There is no child with both ears decidedly defective in the eighth grade, but they are found in all the other grades. The auditory defects, like the visual, cannot be considered an important factor in the retardation of the children of the lower grades.

As in vision, children with normal sense of hearing were not re-tested at fifteen, and no group summary of the few who were re-tested has been made.

Table 7
Auditory acuity. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	*Group	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	a.	49	63.6	36	60.1	27	67.5	17	2	82.7		29	70.8	44	80.1	34	87.2	20	1	84.0	
	b.	12	15.6	8	12.3	4	10.0	0		0.0		6	14.6	7	12.7	2	5.1	1		4.0	
	c.	1	1.3	7	10.8	2	5.0	0		0.0		3	7.3	2	3.6	0	0.0	0		0.0	
	d.	8	10.4	4	6.1	3	7.5	1		4.3		2	4.9	2	3.6	2	5.1	2		8.0	
	e.	5	6.5	4	6.1	3	7.5	3		13.0		0	0.0			1	2.6	1		4.0	
	f.	2	2.6	3	4.6	1	2.5	0				1	2.4								
	Total	77		65		40		21	2			41		55		39		24	1		
	Omitted	9		3		3		1	0			2		4		4		0	2		
Parochial School	a.	26	72.5	30	62.5	32	60.4	25	1	74.3		14	61.0	28	84.3	40	86.9	18	1	67.9	
	b.	7	19.4	7	14.6	9	17.0	4	1	14.3		3	13.0	3	7.9	5	10.9	4	1	17.8	
	c.	0	0.0	4	8.3	4	7.5	3	0	8.6		3	13.0	1	2.6	1	2.2	1		3.6	
	d.	1	2.7	5	10.4	4	7.5		1	2.8		3	13.0	1	2.6			3		10.7	
	e.	1	2.7	0	0.0	2	3.8					0		1	2.6						
	f.	1	2.7	2	4.2	2	3.8					0		4	10.5						
	Total	36		48		53		32	3			23		38		46		26	2		
	Omitted	2		11		12		5	0			3		5		9		5	1		

*Group a.—Both ears normal (i.e., 100 cm. or more).
Group b.—One ear normal, one slightly defective (i.e., 50 to 100 cm.)
Group c.—One ear normal, one very defective (i.e., less than 50 cm.)
Group d.—Both ears slightly defective.
Group e.—One ear slightly defective, one very defective.
Group f.—Both ears very defective.

Section V—Vital Capacity

Table 8—Vital capacity—14 years.

Table 9—Vital capacity—15 years.

Materials—A wet spirometer, reading tenths of a liter on one side and cubic inches on the other.

Method of taking the measurements—The child was first instructed to throw his shoulders back, take as deep a breath as he could through his nose, and blow it out through his mouth. The experimenter then instructed him about as follows:

"This instrument is to measure how well you can breathe—how good a pair of lungs you have. I will show you how to do it. First I put this mouthpiece into my mouth, close my lips tight around it, and then breathe in all the air I can through my nose. Then I blow it all out through this tube, and see how high I can make that go. (The experimenter does it.) Now you try it (putting in a new mouthpiece). Breathe in every bit of air you can, and force it all out. Blow hard, but not too fast."

The child then tried it while the experimenter watched, and criticized the result. Many children of fourteen, particularly those who have had no gymnastic training, find it very difficult to carry out the instructions. They seem to be lacking in sufficient control of their bodies to perform the test. Some children are unable to breathe in air through the nose. In such cases the experimenter allowed the child to breathe in the air through the mouth, and gave several practice trials before taking readings. When he thought the child was performing the test as well as he could, he took three readings, and recorded the best of the three. Some of the very low records, however, are undoubtedly due to the fact that within the very limited time possible for practice, some children were unable to learn to perform the test correctly.

Method of dealing with results—The readings were recorded in liters and fractions of liters. The smallest divisions marked on the scale were tenths of liters, but the spaces were large enough to allow readings of halves and quarters of the space. Accordingly, the readings may be regarded as cubic centimeters on a

scale whose smallest subdivisions indicate 25 c.cs. The results were merely summed up in the tables presented below:

RESULTS

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	2057	2255	1850	1965
50 perc.	2305	2600	2074	2176
75 perc.	2622	2947	2333	2488
Q	282	346	241	259
Limits—				
Lower	1100	1325	900	1000
Upper	3600	4400	3125	3200

Vital capacity in cubic centimeters, percentiles and limits

Correlation with school grade:

Graph 8a—Boys, 14 years. Graph 8b—Girls, 14 years.

Graph 9a—Boys, 15 years. Graph 9b—Girls, 15 years.

There is a positive correlation with school grade for both sexes, and at both ages. It is somewhat more marked and more consistent among the boys than among the girls. In the group of boys, the correlation is more marked at fifteen than at fourteen.

Comparison of sex and school.

Graph 8c—14 years.

Graph 9c—15 years.

Sex—Both the percentiles and the graphs show a decided superiority of the boys over the girls in vital capacity. The difference is even greater at fifteen years than at fourteen. The percentiles show a group difference of about 200 c.cs. at fourteen years, and about 400 c.cs. at fifteen years.

School—The public school children are superior in this test to the parochial school group. The difference is decided for the girls at both ages, and for the boys at fourteen years. In the fifteen-year graphs the parochial school boys are as good as the public school.

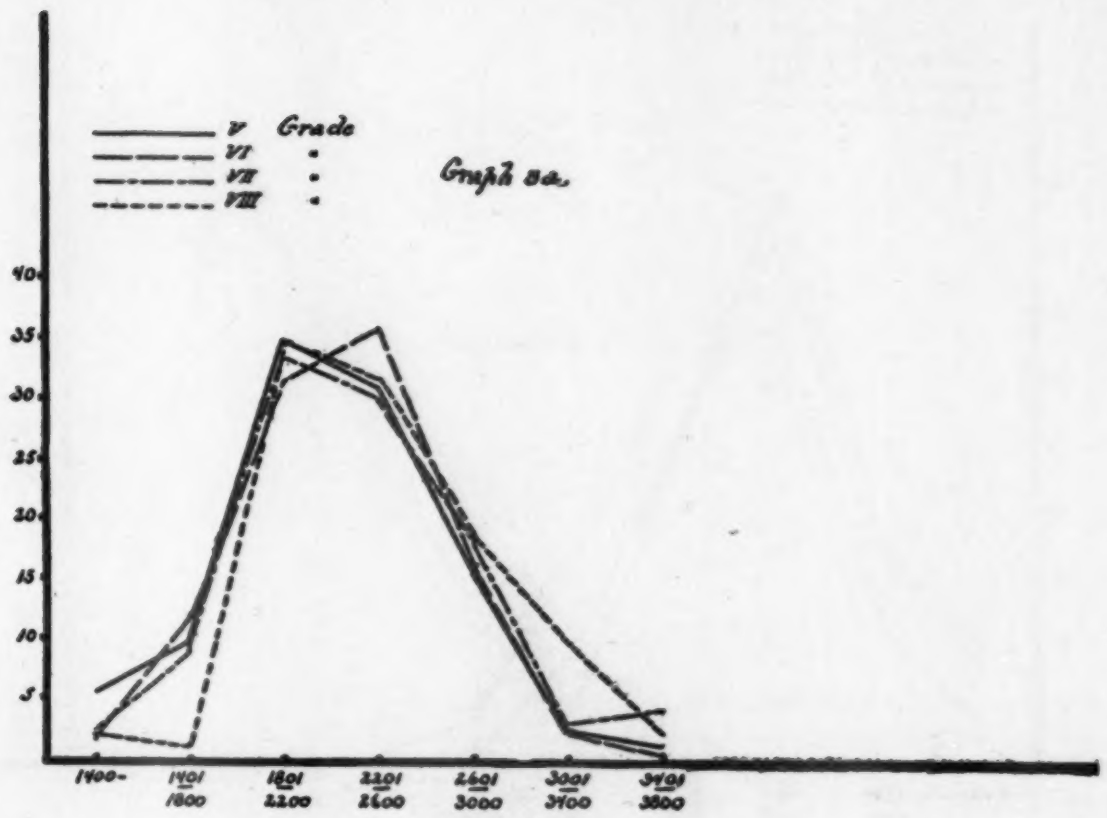
Age—Both sexes improve in vital capacity from fourteen to fifteen years; but the boys gain much more than the girls, who as a group gain a little over 100 c.c. while the boys gain a little over 250 c.c.

TABLE 8
Vital capacity. 14 years

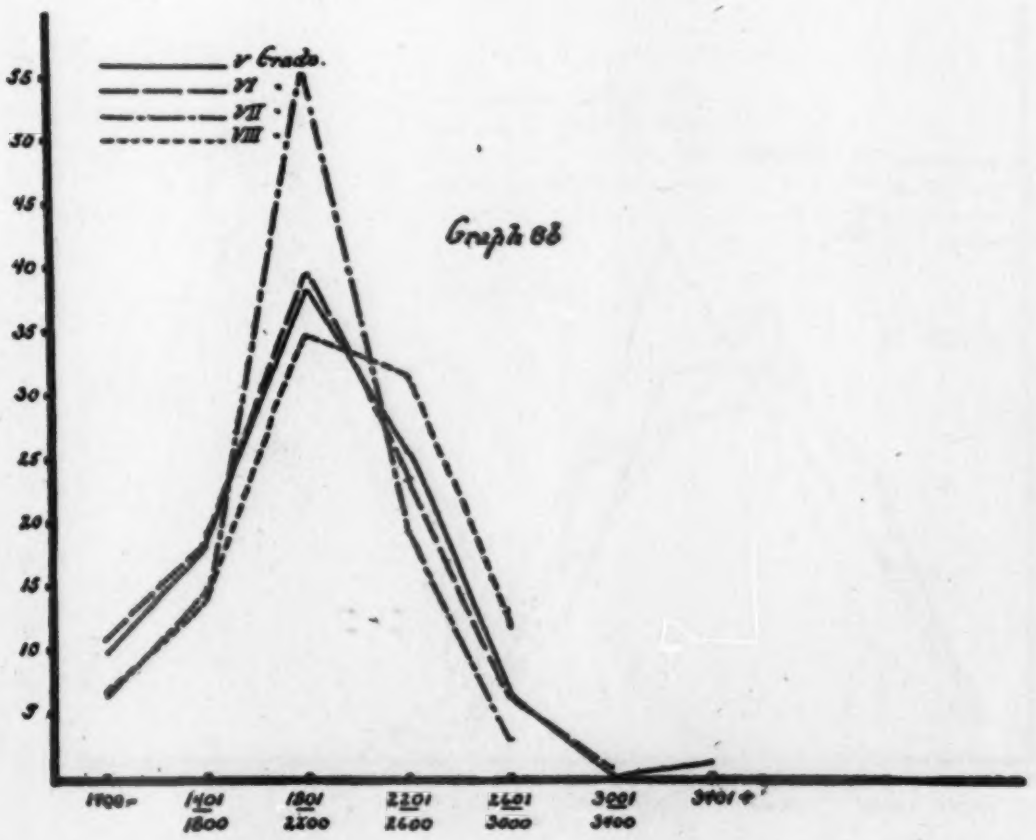
School	Grade	Boys V No.	Boys V %	Boys VI No.	Boys VI %	Boys VII No.	Boys VII %	Boys VIII	Boys IX	Boys VIII and IX %	Girls V No.	Girls V %	Girls VI No.	Girls VI %	Girls VII No.	Girls VII %	Girls VIII	Girls IX	Girls VIII and IX %
Public School	c.cs.	No.	%	No.	%	No.	%	No.	No.	%	No.	%	No.	%	No.	%	No.	No.	%
	1200—	1		0		0		0			3		1		0		0		
	1201 - 1400	1	2.5	1	1.5	0	0.	0	1	4.3	2	11.6	2	5.2	3	7.3	1	1	7.4
	1401 - 1600	1		3		0		0			3		4		3		2		
	1601 - 1800	4	6.1	2	7.7	3	7.0	0		0.0	4	16.3	5	15.8	5	19.5	1	1	14.8
	1801 - 2000	12		6		3		3			8		12		11		0		
	2001 - 2200	16	34.6	13	29.2	12	34.9	5		34.7	8	37.2	10	38.5	10	51.2	9		33.3
	2201 - 2400	18		18		4		2			5		10		5		5	1	
	2401 - 2600	6	29.6	7	38.5	9	30.2	6		34.8	5	23.2	6	28.0	3	19.5	2		29.6
	2601 - 2800	10		6		7		2			3		4		1		2		
	2801 - 3000	6	19.7	7	20.0	1	18.6	1		13.0	1	9.3	2	10.5	0	2.4	2		14.8
	3001 - 3200	2		1		1		2			0		1		0		0		
	3201 - 3400	2	5.0	1	3.0	0	2.3	0		8.7	0	0.0	0	1.7	0	0.0	0		0.0
	3401 - 3600	2		0		3		0	1		0		0		0		0		
	3600 +	0	2.5	0	0.0	0	7.0	0		4.3	1	2.3	0	0.0	0	0.0	0		0.0
	Total	81		65		43		21	2		43		57		41		24	3	
	Omitted	5		3		0		1	0		0		2		2		0	0	
Parochial School	1200—	0		0		2		0			0		4		2		0		
	1201 - 1400	3	8.1	1	1.7	1	4.8	0		0.0	2	8.0	3	16.6	1	5.7	2		6.1
	1401 - 1600	1		5		2		0			1		5		4		0	1	
	1601 - 1800	4	13.5	4	15.9	5	11.1	1		2.6	4	20.0	4	21.4	2	11.5	4		15.1
	1801 - 2000	6		8		8		7			6		10		17		7	1	
	2001 - 2200	7	35.1	11	33.3	12	31.7	5	1	34.2	4	40.0	7	40.5	14	59.6	4		36.3
	2201 - 2400	6		15		12		7			3		8		8		7	1	
	2401 - 2600	6	32.4	4	33.3	7	30.1	4		28.9	4	28.0	0	19.0	2	19.2	3		33.3
	2601 - 2800	4		3		5		5			1		0		1		3		
	2801 - 3000	0	10.8	4	12.4	6	17.4	4		23.7	0	4.0	1	2.4	1	3.8	0		9.1
	3001 - 3200	0		0		2		2	2		0		0		0		0		
	3201 - 3400	0	0	1	1.7	0	3.2	0		10.5	0	0.0	0	0.0	0	0.0	0		0.0
	3401 - 3600	0		1		1		0			0		0		0		0		
	3600 +	0	0	0	1.7	0	1.6	0		0 0	0	0.0	0	0.0	0	0.0	0		0.0
	Total	37		57		63		35	3		25		42		52		30	3	
	Omitted	1		2		2		2	0		1		1		3		1	0	

TABLE 9
Vital capacity. 15 years

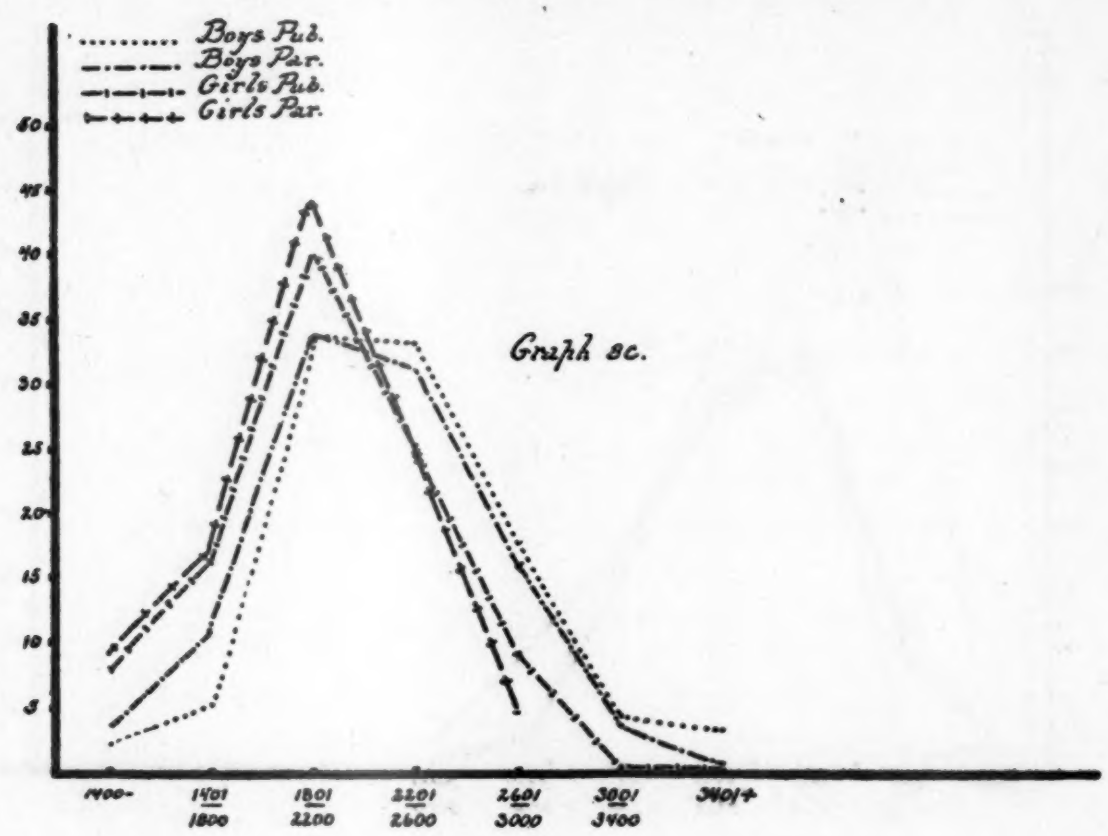
School	Grade	Boys V No.	Boys V %	Boys VI No.	Boys VI %	Boys VII No.	Boys VII %	Boys VIII No.	Boys IX No.	Boys VIII and IX %	Girls V No.	Girls V %	Girls VI No.	Girls VI %	Girls VII No.	Girls VII %	Girls VIII No.	Girls IX No.	Girls VIII and IX %
PUBLIC SCHOOL	c.cs. 1600—	0		0		0		0	1		2		2		1		0		
	1601 - 1800	1	1.3	1	1.6	0	0	0		4.2	2	11.8	2	7.8	2	8.3	1		5.
	1801 - 2000	5		5		2		1			3		11		7		3		
	2001 - 2200	14	24.	5	16.1	4	14.3	1		8.3	10	38.2	9	39.2	8	41.7	4		35.
	2201 - 2400	16		13		8		4			7		11		6		2		
	2401 - 2600	6	27.8	7	32.3	4	28.6	6		41.7	6	38.2	6	33.3	5	30.5	4		30.
	2601 - 2800	11		8		7		2			3		8		6		3		
	2801 - 3000	15	32.9	8	25.8	5	28.6	6		33.3	1	11.8	1	17.7	0	16.7	2	1	30.
	3001 - 3200	3		8		5		0					1		1				
	3201 - 3400	3	7.6	4	19.3	5	23.8	2		8.3		0.0		1.9		2.8			0.0
	3401 - 3600	3		3		1		0											
	3601 - 3800	0	3.8	0	4.8	1	4.8	0		0.0		0.0		0.0		0.0			0.0
	3801 - 4000	1		0		0		0											
	4000+	1	2.5	0	0.0	0	0.0	0	1	4.2		0.0		0.0		0.0			0.0
	Total	79		62		42		22	2		34		51		36		19	1	
	Omitted	1				1					2		2				1		
PAROCHIAL SCHOOL	1600—	1		3		1		0			0		2		1		0		
	1601 - 1800	0	2.9	1	7.7	2	4.9	0		0	3	12.5	3	13.9	2	6.	4		14.8
	1801 - 2000	3		5		2		0			5		8		10		3		
	2001 - 2200	4	20.6	4	17.3	9	18.0	3		9.4	7	50.	9	47.2	17	54.	5	1	33.3
	2201 - 2400	5		12		6		3			2		4		11		3		
	2401 - 2600	6	32.3	8	38.5	10	26.2	1		12.5	3	20.8	5	25.0	2	26.	5	1	33.3
	2601 - 2800	6		8		3		8			3		3		2		2		
	2801 - 3000	3	26.5	4	23.1	11	22.9	7		46.9	1	16.7	1	11.1	1	6.	0		7.4
	3001 - 3200	3		2		6		7					1		4		3		
	3201 - 3400	2	14.7	4	11.5	6	19.7	2		28.1				2.8		8.			11.1
	3401 - 3600	1		0		4		0											
	3601 - 3800	0	2.9	1	1.9	0	6.5	1		3.1		0.0		0.0		0.0			0.0
	3801 - 4000	0		0		1		0											
	4000+	0	0.0	0	0.0	0	1.6	0		0.0		0.0		0.0		0.0			0.0
	Total	34		52		61		32			24		36		50		25	2	
	Omitted	1		1		1		1					1		1		1	1	



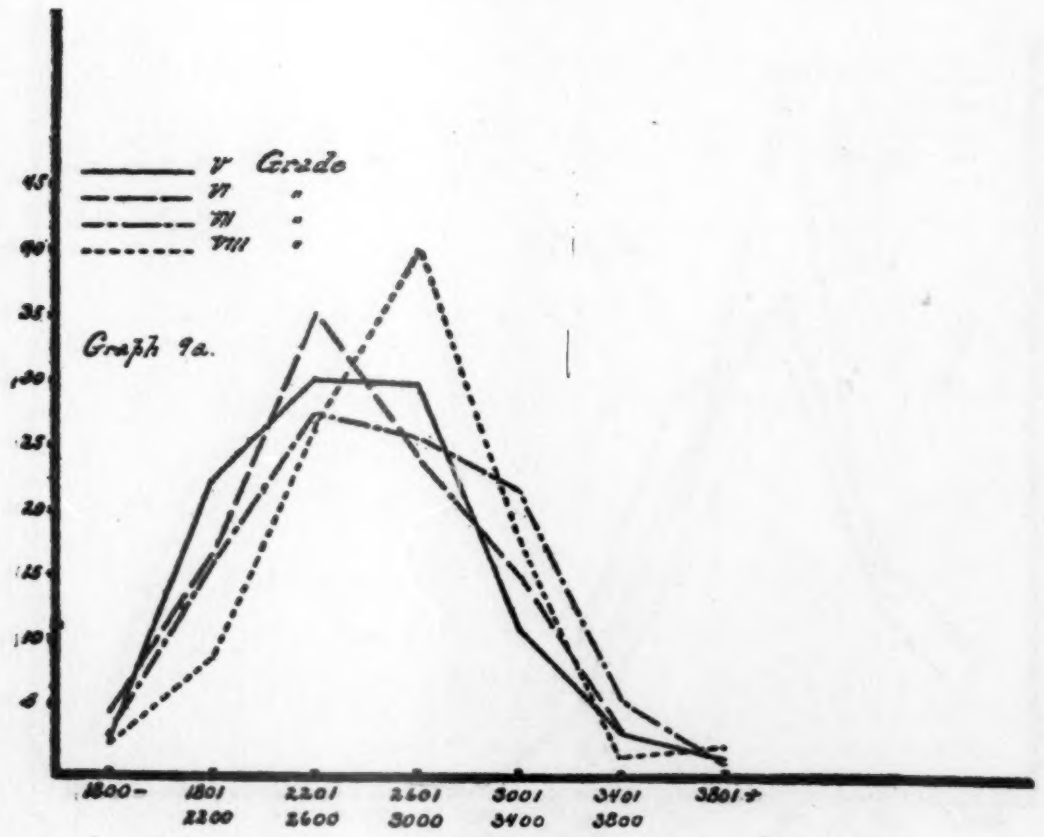
VITAL CAPACITY. 14 YEARS. BOYS.



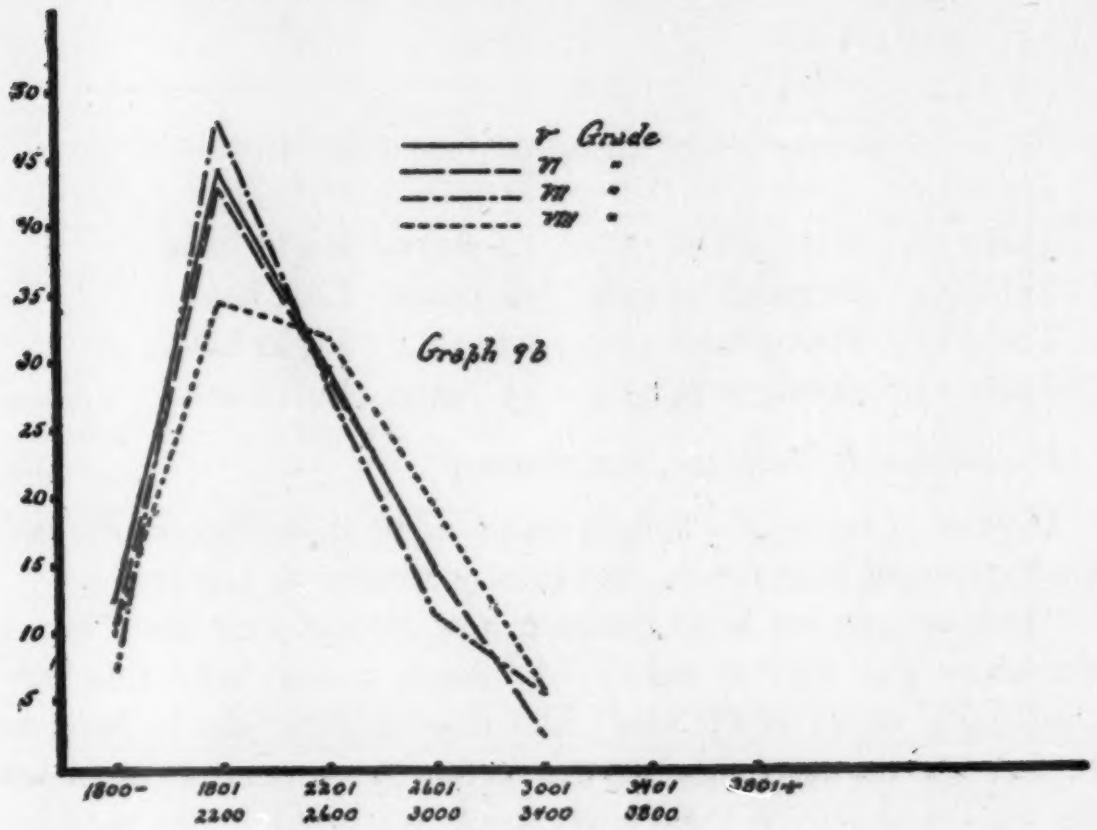
VITAL CAPACITY. 14 YEARS. GIRLS.



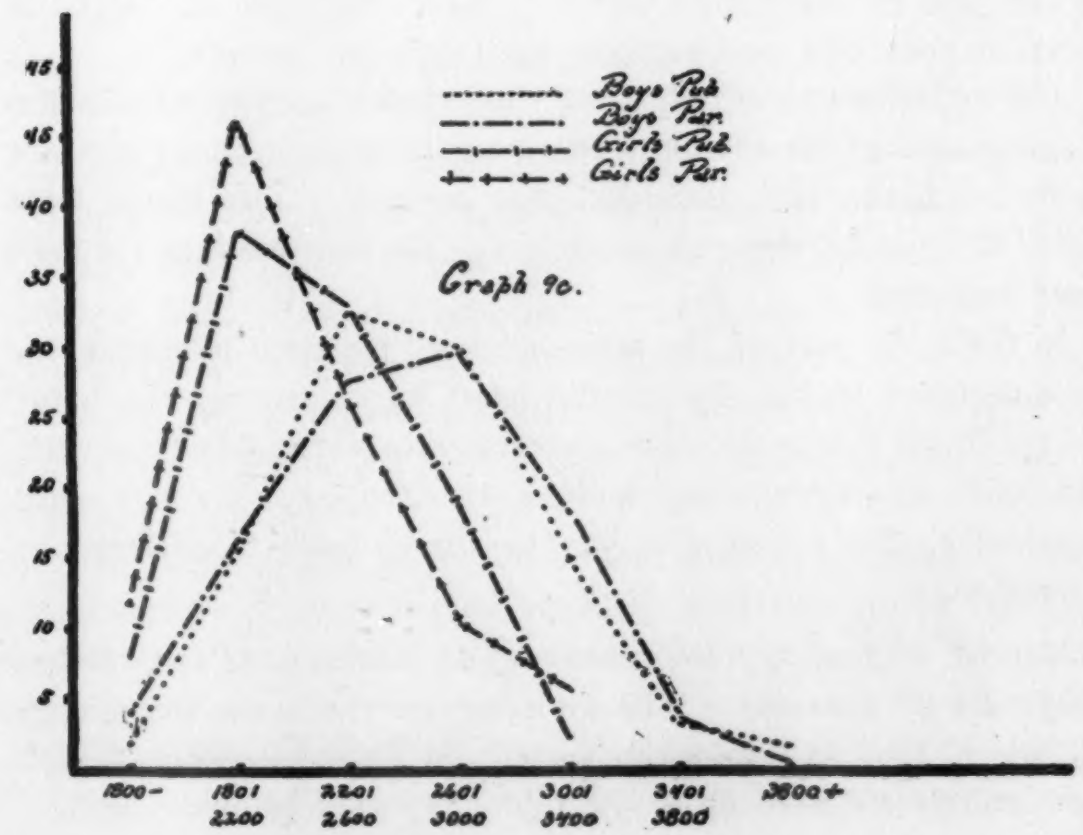
VITAL CAPACITY. 14 YEARS.



VITAL CAPACITY. 15 YEARS. BOYS.



VITAL CAPACITY. 15 YEARS. GIRLS.



VITAL CAPACITY, 15 YEARS.

Section VI—Strength of the Hand

Table 10. Strength of grip. 14 years. Right hand.
Table 11. Strength of grip. 14 years. Left hand.
Table 12. Strength of grip. 15 years. Right hand.
Table 13. Strength of grip. 15 years. Left hand.

Materials—A Smedley dynamometer.

Method of taking the measurement—The experimenter showed the instrument to the child, and then proceeded as follows:

"This instrument is to measure how strong your hand is. I will show you how it works. I take it in my hand this way (holding it down at the side) and then squeeze just as hard as I can. The harder I squeeze, the farther those pointers move on the scale, and one of them stays in place when I let go to show how hard I have squeezed. See? Now hold out your hand and let me see how big it is. (Adjusts the instrument roughly to the size of the child's hand.) Now you take it. Hold it down at your side, and see how hard you can squeeze."

The experimenter watched the child closely, and if he saw him pushing against his side with the instrument, he warned him not to do so again, and discarded that reading. The hands were tested alternately, three times each, and the best reading for each hand recorded.

In the early part of the series of tests we tried to adjust the dynamometer to the size of the hand by measuring the hand, but we found this method as uncertain as an empirical adjustment, and more time-consuming, and so we dropped it. After some experience, the adjustment can be made fairly accurately by inspection.

Method of dealing with results—The results were recorded in kilograms of pressure. The divisions on the scale were large enough so that half kilograms could be recorded. The results were merely summed up in the tables reported below.

RESULTS

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	21.4	25.4	19.8	23.2
50 perc.	24.9	28.9	22.7	25.9
75 perc.	28.0	34.7	26.4	28.7
Q	3.3	4.65	3.3	2.75
Limits—				
Lower	11.5	15	9	13.0
Upper	45.0	48	37	35.0

Strength of grip in kilograms. Right hand. Percentiles and limits

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 per.	21.1	24.4	19.5	21.3
50 per.	24.6	28.5	22.7	24.5
75 per.	27.8	33.5	25.7	27.6
Q	3.35	4.55	3.1	3.1
Limits—				
Lower	12.0	14.0	8.0	11.0
Upper	45.0	47.0	37.0	35.0

Strength of grip in kilograms. Left hand. Percentiles and limits

Correlation with School Grade.

Graph 10a. Boys. Right hand. 14 years.

Graph 10b. Girls. Right hand. 14 years.

Graph 12a. Boys. Right hand. 15 years.

Graph 12b. Girls. Right hand. 15 years.

Graphs are presented for the right hand only, though an inspection of the tables for the left hand shows a similar state of affairs.

In the case of the boys, there is a positive correlation with school grade, which is more marked at fifteen years than at fourteen. The girls show no correlation with school grade at either age.

Comparisons of Sex and School.

Graph 10c. 14 years.

Graph 12c. 15 years.

Sex—Both the percentiles and the graphs show that the boys are stronger than the girls at both ages. There is an average difference of about 2 kilograms at fourteen years, but at fifteen years, the difference is still greater, showing particularly in the 75 percentiles, where it amounts to 5 kilograms. In other words, the boys not only gain in strength faster than the girls, but they become more variable as a group, due to the fact that more of them make very large gains.

School—The public school children, both boys and girls, are stronger than the parochial school children at both ages.

Age—Both boys and girls gain in strength from fourteen to fifteen years. While the boys as a group gain almost 5 kilograms in the strength of the right hand, the girls gain only 3 kilograms. With the left hand the gain is about 4 kilograms for the boys, and a little less than two for the girls.

Right- and left-handedness—No attempt was made in these tables to take account of left-handed individuals. While there was a large number of children who showed superiority of the left hand in some one test of the three (grip, steadiness or rapidity) there were comparatively few who showed a consistent left-handedness. Taking into consideration the tests of both years, there were thirteen boys and eight girls who showed a superiority of the left-hand in each of the three tests.

In the measurements of grip, there were at fourteen years, 133 boys, and 94 girls whose left hands were superior to the right in strength. Of the 133 boys, only 30, and of the 94 girls, only 21, showed a superiority of the left hand in either of the other tests. Of the 133 boys, only 5; and of the 94 girls, only 2, showed a superiority of the left hand in both the other tests.

Unfortunately the test of strength was omitted (because of the long time required by the maker to repair the dynamometer) in a large number of fifteen-year children. Only 93 of the original 133 boys were retested at fifteen years. Of this 93, only 39 showed a superiority of the left hand the second time, while there were 32 boys whose left hand grip was superior at fifteen years, though it had not been at fourteen.

Of the 94 girls whose left hand was superior in grip at four-

teen, 67 were retested at fifteen years. Of the 67, only 15 showed a stronger left hand in the second test, while 18 girls showed a stronger left hand at fifteen years, though they had not at fourteen.

In the fifteen-year series there were 71 boys and 33 girls whose left hands were superior to the right in strength. Of the 71 boys, only 17, and of the 33 girls, only 7 showed superiority of the left hand in either of the other tests. Of the 71 boys, only 3, and of the 33 girls, only 2, showed a superiority of the left hand in both the other tests.

In view of the variability in this respect, and the small number of clearly left-handed individuals, we feel that no large error has crept into the results by our failure to exclude left-handed individuals, or to classify them separately.

A superiority of the left hand in strength either at fourteen or at fifteen—not at both ages—appeared as the only indication of a superior left hand in 103 boys and 64 girls. It is evident therefore that superior strength of the left hand, taken alone, is no indication of left-handedness.

TABLE 10
Strength of Grip. 14 years. Right Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX		VIII and IX	V		VI		VII		VIII	IX		VIII and IX
	Kg.	No.	%	No.	%	No.	%	No.	No.		%	No.	%	No.	%	No.	%	No.	No.		%
Public School	12.5—	0		0		0		0				0		0		0		0			
	12.6 - 14.5	1	1.2	0	0.	0	0.	0			0.	1	2.4	1	1.7	0	0.	0	1		3.7
	14.6 - 16.5	2		2		2		1	1			3		3		3		1			
	16.6 - 18.5	5	8.2	1	4.6	1	6.9	1			12.5	2	11.9	2	8.5	4	16.3	1			7.4
	18.6 - 20.5	10		6		3		0				5		10		4		4			
	20.6 - 22.5	9	22.4	4	15.3	5	18.6	4			16.7	8	30.9	9	32.3	7	25.6	4	1		33.3
	22.6 - 24.5	16		9		5		6				5		5		2		4			
	24.6 - 26.5	13	34.1	17	39.9	4	20.9	2			33.3	6	26.2	11	27.1	9	25.5	3			25.9
	26.6 - 28.5	9		12		8		3				5		7		5		2			
	28.6 - 30.5	2	12.9	8	30.8	6	32.5	1	1		20.8	4	21.4	7	23.6	2	16.2	2			14.8
	30.6 - 32.5	8		2		5		2				3		3		5		1	1		
	32.6 - 34.5	5	15.3	2	6.2	1	13.9	2			16.6	0	7.1	1	6.8	1	13.9	0			7.4
	34.6 - 36.5	2		0		1		0				0		0		0		1			
	36.6 - 38.5	1	3.5	1	1.5	1	4.6	0			0.	0	0.	0	0	1	2.3	1			7.4
	38.6 - 40.5	0		0		1		0				0		0		0		0			
	40.6 - 42.5	2	2.3	0	0.0	0	2.3	0			0.	0	0.	0	0.	0	0.	0			0.
	42.6 - 44.5	0	0.0	1	1.5	0		0			0.	0	0.	0	0.	0	0.	0			0.
	Total	85		65		43		22	2			42		59		43		24	3		
	Omitted	1		3								1		0							
Parochial School	12.5—	1		0		1		0				2		0		0		1			
	12.6 - 14.5	0	2.7	0	0.	1	3.2	0			0.	2	15.4	2	4.6	3	5.4	1			5.8
	14.6 - 16.5	2		3		0		2				0		3		7		1			
	16.6 - 18.5	3	13.5	4	11.9	4	6.2	1			7.7	1	3.8	2	11.6	4	20.0	1			5.8
	18.6 - 20.5	3		7		10		3				2		7		7		5	1		
	20.6 - 22.5	4	18.9	9	27.2	8	28.1	8			28.2	7	34.6	11	41.9	11	32.7	7			38.2
	22.6 - 24.5	6		8		8		0				1		4		5		5			
	24.6 - 26.5	9	40.5	14	37.3	14	34.4	7			17.9	4	19.2	6	23.2	11	29.1	5	1		32.3
	26.6 - 28.5	5		4		8		6				5		3		3		0			
	28.6 - 30.5	2	18.9	8	20.4	3	17.2	3	1		25.6	2	26.9	5	18.6	4	12.7	4			11.8
	30.6 - 32.5	2		1		3		4				0		0		0		1	1		
	32.6 - 34.5	0	5.4	0	1.7	1	6.3	0	2		15.3	0	0.	0	0.	0	0.	0			5.9
	34.6 - 36.5	0		0		1		1				0		0		0		0			
	36.6 - 38.5	0	0.	1	1.7	0	1.6	1			5.6	0	0.	0	0.	0	0.	0			0.
	38.6 - 40.5	0		0		1		0				0		0		0		0			
	40.6 - 42.5	0	0.	0	0.	0	1.6	0			0.0	0	0.	0	0.	0	0.	0			0.
	42.6 - 44.0	0	0.	0	0.	1	1.6	0			0.	0	0.	0	0.	0	0.	0			0.
	Total	37		59		64		36	3			26		43		55		31	3		
	Omitted	1		0		1		1				0		0		0		0	0		

TABLE 11

Strength of Grip. 14 years. Left Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX		VIII and IX	V		VI		VII		VIII	IX		VIII and IX
	Kg.	No.	%	No.	%	No.	%	No.	No.		%	No.	%	No.	%	No.	%	No.	No.		%
Public School	12.5—	0		0		0		0				0		0		0		0			
	12.6 - 14.5	1	1.2	0		1	2.3	1			4.2	0		0		1	2.3	0	1		3.7
	14.6 - 16.5	2	2.3	1	1.5	1	2.3	0	1		4.2	5	11.9	3	5.1	4	9.3	1			3.7
	16.6 - 18.5	6	7.1	1	1.5	2	4.6	0			0.0	1	2.4	6	10.2	3	7.0	3			11.1
	18.6 - 20.5	12	14.1	7	10.6	4	9.3	4			16.7	5	11.9	9	15.3	7	16.3	1			3.7
	20.6 - 22.5	14	16.5	9	13.6	2	4.6	3			12.5	12	28.6	11	18.6	9	20.3	4	1		18.5
	22.6 - 24.5	12	14.1	7	10.6	8	18.6	4			16.7	4	9.5	6	10.2	2	4.6	2			7.4
	24.6 - 26.5	8	9.4	18	27.3	8	18.6	3			12.5	7	16.7	8	13.6	8	18.6	6			22.2
	26.6 - 28.5	8	9.4	8	12.1	5	11.6	0			0.0	3	7.1	6	10.2	2	4.6	2			7.4
	28.6 - 30.5	12	14.1	10	15.1	5	11.6	2			8.3	3	7.1	7	11.9	4	9.3	2	1		11.1
	30.6 - 32.5	4	4.7	0		3	7.0	3	1		16.7	2	4.8	1	1.7	2	4.6	2			7.4
	32.6 - 34.5	1	1.2	3	4.5	1	2.3	2			8.3	0		1	1.7	1	2.3	0			
	34.6 - 36.5	3	3.5	0		2	4.6	0			0.0	0		0	0.0	0		1			3.7
	36.6 - 38.5	1	1.2	0	0.	0		0			0.0	0		1	1.7	0		0			
	38.6 - 40.5	1	1.2	1	1.5	0		0			0.0	0		0		0		0			
	40.6+	0		1	1.5	1	2.3	0			0.0	0		0		0		0			
	Total	85		66		43		22	2			42		59		43		24	3		
	Omitted	1		2																	
Parochial School	12.5—	0		0		1	1.6	0				2	7.7	1	2.3	0		0			
	12.6 - 14.5	3	7.9	1	1.7	0	0.0	0				0	.	1	2.3	3	5.4	2			5.9
	14.6 - 16.5	1	2.6	3	5.1	4	6.4	2			5.0	1	3.8	4	9.3	4	7.3	1			2.9
	16.6 - 18.5	2	5.3	3	5.1	3	4.8	1			2.5	1	3.8	3	7.0	6	10.9	1			2.9
	18.6 - 20.5	6	15.8	5	8.5	7	11.1	4			10.0	3	11.5	7	16.3	7	12.7	8			23.5
	20.6 - 22.5	2	5.3	5	8.5	8	12.7	7			17.5	9	34.6	8	18.6	8	14.5	6			17.6
	22.6 - 24.5	7	18.4	14	23.7	10	15.9	5			12.5	3	11.5	10	23.3	11	20.0	4	1		14.7
	24.6 - 26.5	6	15.8	15	25.4	14	22.2	4			10.0	4	15.4	4	9.3	8	14.5	5	1		17.6
	26.6 - 28.5	8	21.0	5	8.5	8	12.7	5			12.5	2	7.7	4	9.3	3	5.4	0			0.0
	28.6 - 30.5	2	5.3	4	6.8	3	4.8	5	1		15.0	1	3.8	1	2.3	4	7.3	2			5.9
	30.6 - 32.5	1	2.6	2	3.4	2	3.2	1	1		5.0	0		0		1	1.8	1	1		5.9
	32.6 - 34.5	0		2	3.4	0	0.0	1	1		5.0	0		0		0		1			2.9
	34.6 - 36.5	0		0		2	3.2	0			0.0	0		0		0		0			
	36.6 - 38.5	0		0		1	1.6	2			5.0	0		0		0		0			
	38.6 - 40.5	0		0		0		0				0		0		0		0			
	40.6+	0		0		0		0				0		0		0		0			
	Total	38		59		63		37	3			26		43		55		31	3		
	Omitted					2															

TABLE 12

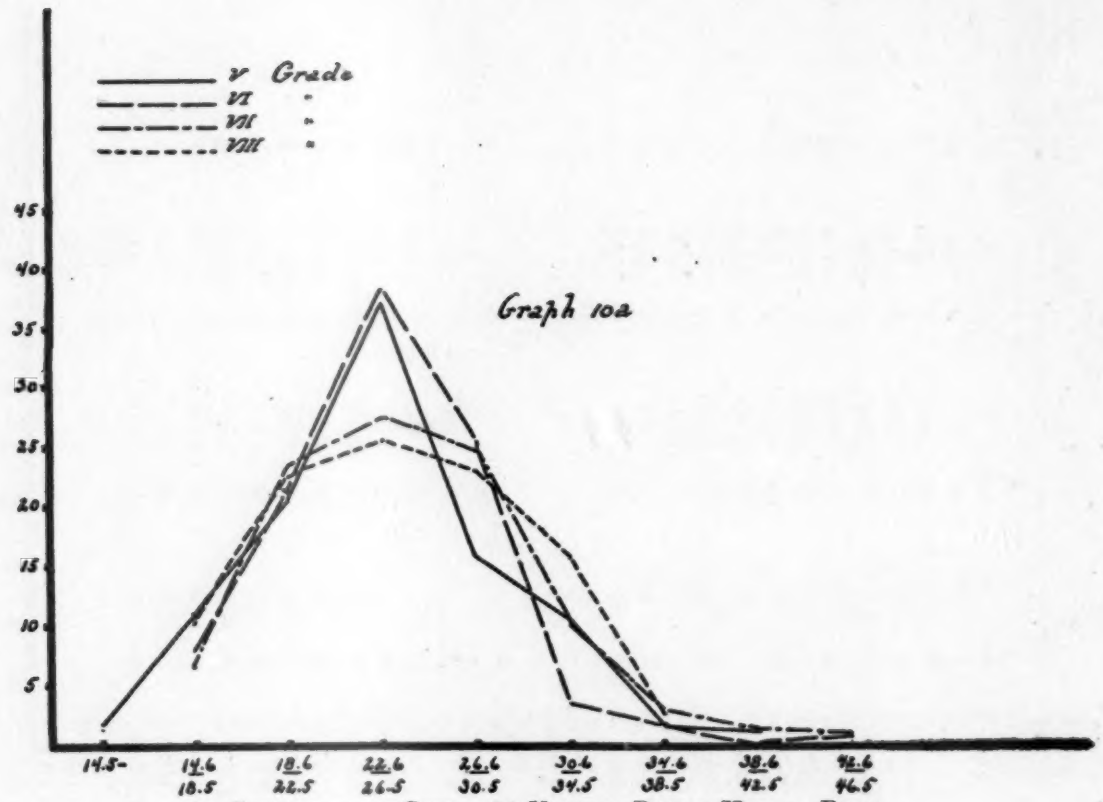
Strength of Grip. 15 years. Right Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Kg.	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	16.5—	0		1	1.9	0		0				1	3.6	0		1	3.6	0			
	16.6 - 18.5	0		0		1	3.3	0				0	0.0	0	0.0	1	3.6	0		0.0	
	18.6 - 20.5	3		1		0		0				0		2		1		1			
	20.6 - 22.5	4	10.	2	5.8	1	3.3	0				2	7.1	3	12.5	1	7.1	1		14.3	
	22.6 - 24.5	7		4		2		2				8		4		6		2			
	24.6 - 26.5	10	24.3	2	11.5	3	16.7	2		22.2		6	50.	8	30.	4	35.7	3		35.7	
	26.6 - 28.5	12		9		3		3				2		14		3		3	1		
	28.6 - 30.5	9	30.	13	42.3	5	26.7	4		38.9		5	25.	5	47.5	4	25.	1		35.7	
	30.6 - 32.5	3		4		1		1				4		4		4		2			
	32.6 - 34.5	7	14.3	3	13.5	2	10.	0		5.6			14.3		10.	3	25.			14.3	
	34.6 - 36.5	5		7		5		1													
	36.6 - 38.5	2	10.	3	19.2	3	26.7	0		5.6											
	38.6 - 40.5	5		1		3		4	1												
	40.6 - 42.5	0	7.1	1	3.8	1	13.3			27.8											
	42.6 - 44.5	1		1		0															
	44.6+	2	4.3		1.9	0															
	Total	70		52		30		17	1			28		40		28		13	1		
	Omitted	10		10		13		5	1			8		13		8		7			
Parochial School	16.5—	0		1	2.2	0		0				0		0		2	5.3	0			
	16.6 - 18.5	0		0		0		0				0		3	11.1	2	5.3	0			
	18.6 - 20.5	3		2		0		1				3		3		1		1			
	20.6 - 22.5	1	14.3	4	13.0	3	6.7	2		12.		2	25.	2	18.5	5	15.8	2		20.	
	22.6 - 24.5	2		6		5		3				2		5		7		3			
	24.6 - 26.5	5	25.	9	32.6	4	20.	3		24.		4	30.	5	37.0	8	39.5	2		33.3	
	26.6 - 28.5	3		6		8		3				4		3		5		1	1		
	28.6 - 30.5	3	21.4	2	17.4	9	37.8	4		28.		2	30.	4	25.9	6	28.9	3		33.3	
	30.6 - 32.5	5		5		3		1				2		1		1		1	1		
	32.6 - 34.5	0	17.8	2	15.2	1	8.9	0		4.		0	10.	1	7.4	1	5.3			13.3	
	34.6 - 36.5	3		3		5		1				1									
	36.6 - 38.5	0	10.7	2	10.9	2	15.5	2		12.			5.								
	38.6 - 40.5	2		3		1		2													
	40.6 - 42.5	0	7.1	0	6.5	2	6.7	2		16.											
	42.6 - 44.5	1		0		1		0													
	44.6 +	0	3.6	1	2.2	1	4.4	1		4.											
	Total	28		46		45		25				20		27		38		13	2		
	Omitted	7		7		17		8				4		10		13		13	1		

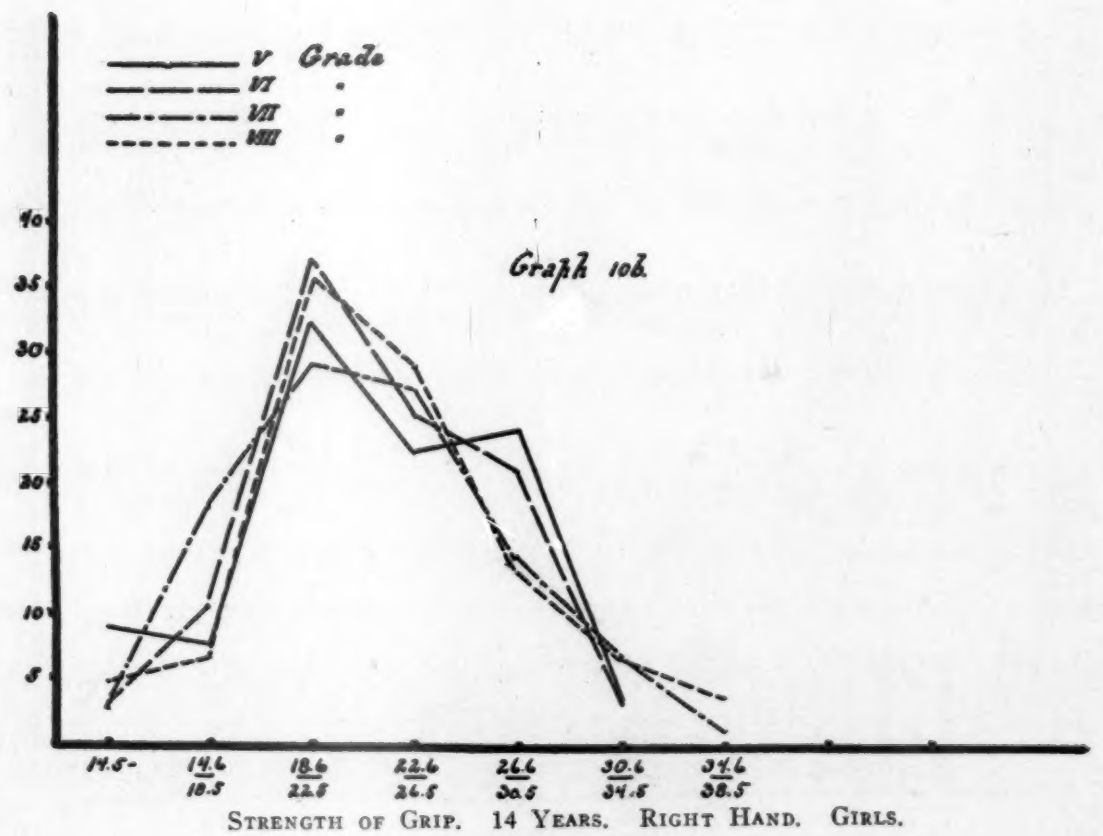
TABLE 13

Strength of Grip. 15 years. Left Hand

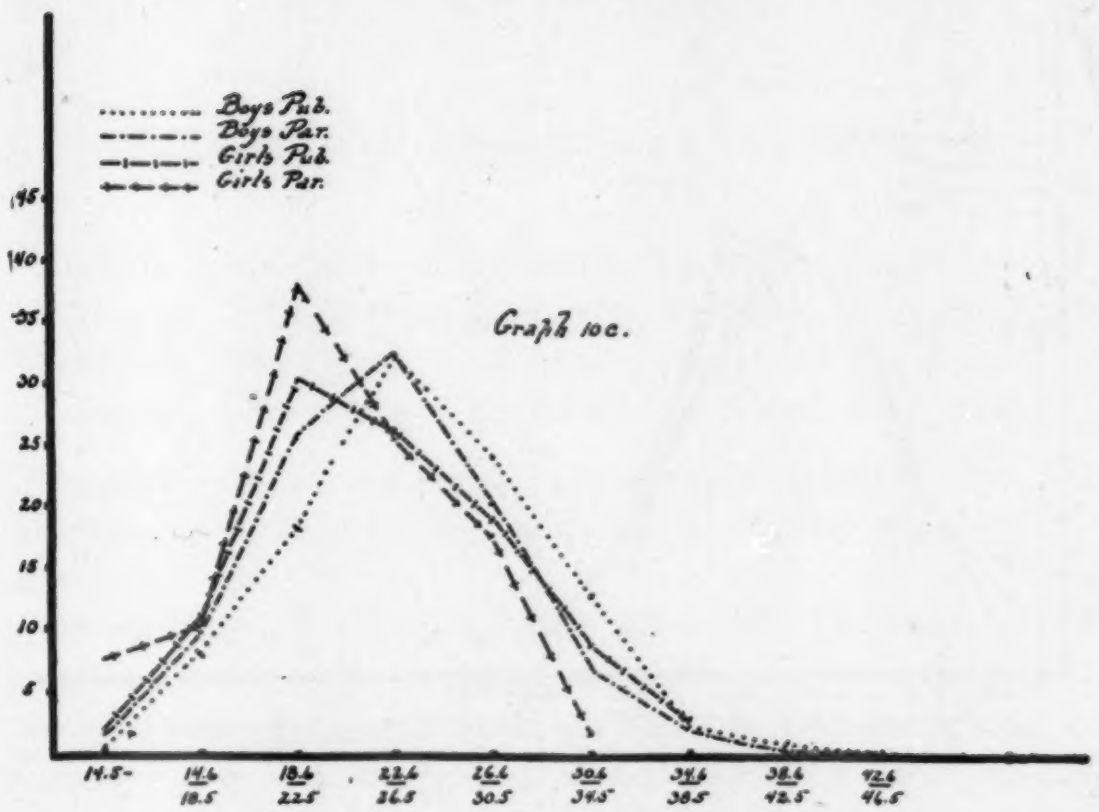
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Kg.	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	14.6—	0	0.0	0	0.0	0		0				1	3.6	0	0.0	0	0.0	0		0.	
	14.6 - 16.5	1	1.4	1	1.9	0		0				0	0.0	0	0.0	1	3.6	1		7.1	
	16.6 - 18.5	0	0.0	0	0.0	0		0				0	0.0	2	5.0	0	0.0	0		0.	
	18.6 - 20.5	5	7.1	1	1.9	0		0				4	14.3	1	2.5	3	10.7	1		7.1	
	20.6 - 22.5	7	10.0	2	3.8	2	6.7	0				3	10.7	5	12.5	6	21.4	3		21.4	
	22.6 - 24.5	8	11.4	6	11.5	4	13.3	2		10.5		7	25.0	7	17.5	5	17.8	2		14.3	
	24.6 - 26.5	9	12.8	7	13.5	4	13.3	3		15.8		6	21.4	10	25.0	1	3.6	2		21.4	
	26.6 - 28.5	8	11.4	5	9.6	2	6.7	5		26.3		1	3.6	8	20.0	4	14.3	1	1	7.1	
	28.6 - 30.5	10	14.3	9	17.3	5	16.7	2		10.5		4	14.3	4	10.0	5	17.8	3		21.4	
	30.6 - 32.5	3	4.3	3	5.8	1	3.3	0		0.0		1	3.6	2	5.0	1	3.6				
	32.6 - 34.5	4	5.7	6	11.5	3	10.0	2		10.5		1	3.6	1	2.5	1	3.6				
	34.6 - 36.5	7	10.0	5	9.6	2	6.7	3		15.8						1	3.6				
	36.6 - 38.5	1	1.4	5	9.6	4	13 3	0		0.0											
	38.6 - 40.5	4	5.7	0	0.0	3	10.0	1		5.3											
	40.5+	3	4.3	2	3.8	0	0.0	0	1	5.3											
	Total	70		52		30		18	1			28		40		28		13	1		
	Omitted	10		10		13		4	1			8		13		8		7			
Parochial School	14.6—	0	0.0	1	2.2	0		0				0		0	0.0	0	0.0	0			
	14.6 - 16.5	1	3.6	0	0.0	0		0				0		1	3.7	2	5.3	0			
	16.6 - 18.5	1	3.6	0	0.0	0		0				1	5.	3	11.1	3	7.9	3		20.	
	18.6 - 20.5	2	7.1	5	10.9	2	4.3	1		4.		1	5.	6	22.2	4	10.5	1		6.7	
	20.6 - 22.5	2	7.1	3	6.5	5	10.9	3		12.		5	25.	4	14.8	7	18.4	1		6.7	
	22.6 - 24.5	3	10.7	6	13.0	3	6.5	4		16.		3	15.	2	7.4	5	13.2	1		6.7	
	24.6 - 26.5	4	14.3	7	15.2	6	13.0	0		0.		2	10.	3	11.1	6	15.8	5		33.3	
	26.6 - 28.5	1	3.6	6	13.0	6	13.0	4		16.		4	20.	4	14.8	6	15.8	2	1	20.0	
	28.6 - 30.5	6	21.4	4	8.7	8	17.4	0		0.		3	15.	3	11.1	3	7.9		1	6.7	
	30.6 - 32.5	3	10.7	6	13.0	4	8.7	4		16.		1	5.	1	3.7	1	2.6				
	32.6 - 34.5	1	3.6	1	2.2	4	8.7	1		4.						1	2.6				
	34.6 - 36.5	1	3.6	2	4.3	4	8.7	3		12.											
	36.6 - 38.5	0	0.0	3	6.5	1	2.2	3		12.											
	38.6 - 40.5	3	10.7	1	2.2	1	2.2	0		0.											
	40.5+	0	0.0	1	2.2	2	4.3	2		8.											
	Total	28		46		46		25				20		27		38		13	2		
	Omitted	7		7		16		8				4		10		13		13	1		



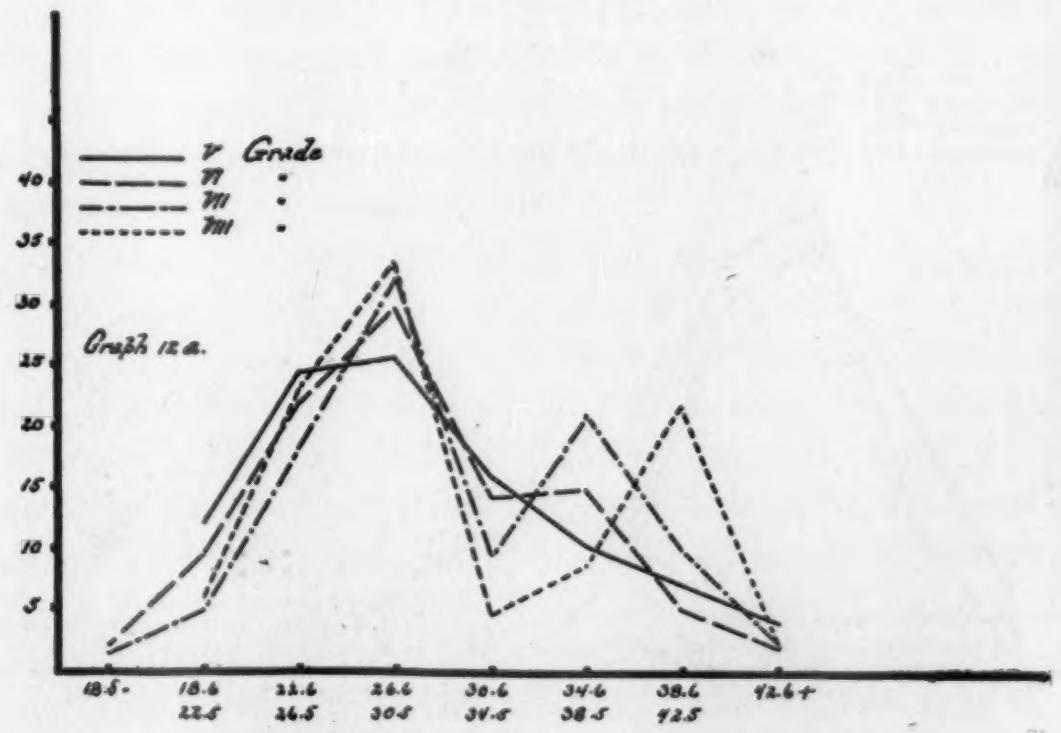
STRENGTH OF GRIP. 14 YEARS. RIGHT HAND. BOYS.



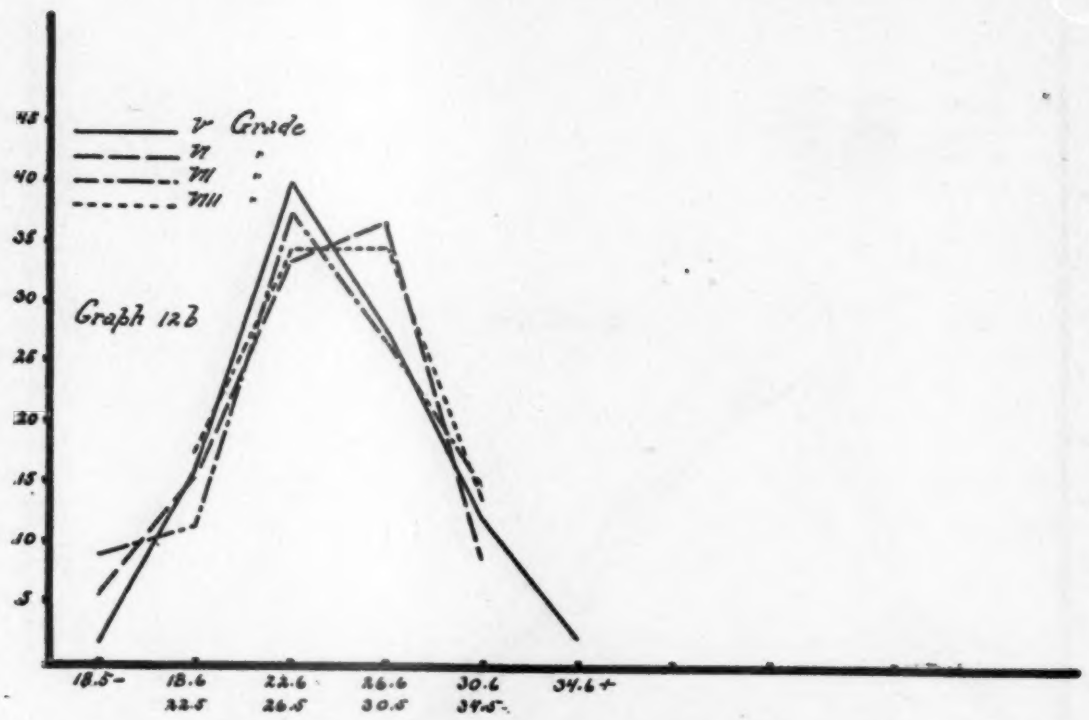
STRENGTH OF GRIP. 14 YEARS. RIGHT HAND. GIRLS.



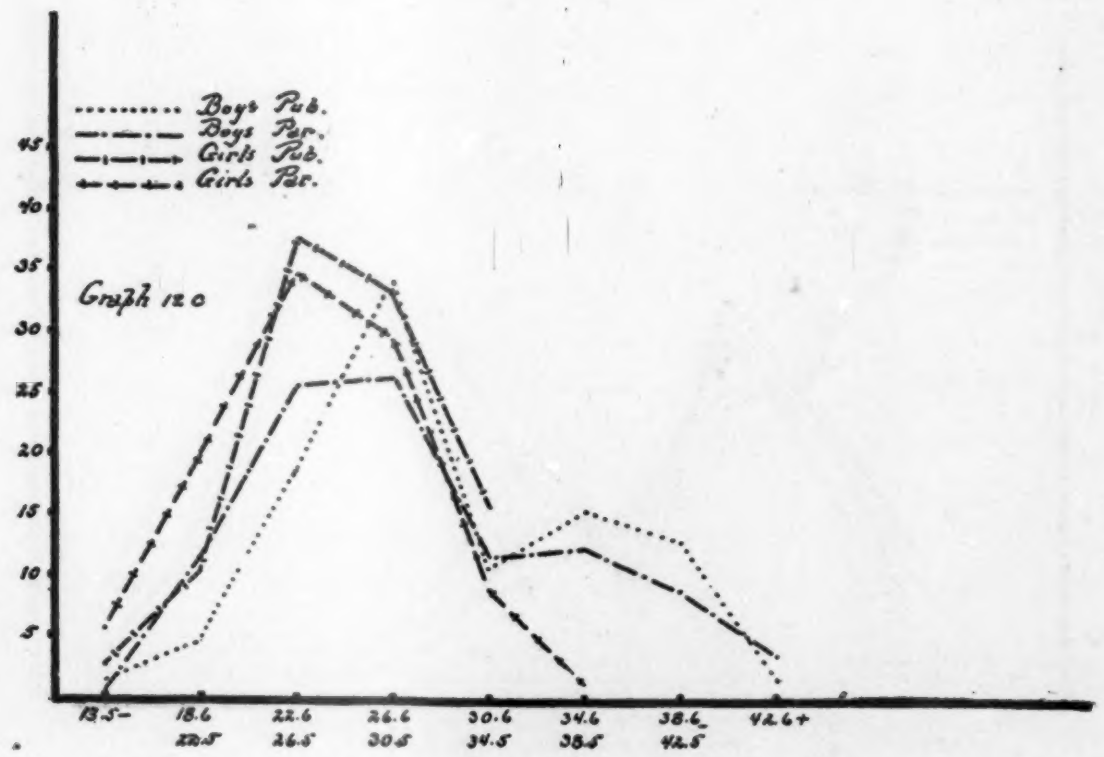
STRENGTH OF GRIP. 14 YEARS. RIGHT HAND. GIRLS.



STRENGTH OF GRIP. 15 YEARS. RIGHT HAND. BOYS.



STRENGTH OF GRIP. 15 YEARS. RIGHT HAND. GIRLS.



STRENGTH OF GRIP. 15 YEARS. RIGHT HAND.

Section VII—Steadiness of the Hand

Table 14. Steadiness of the hand. 14 years. Right hand.
Table 15. Steadiness of the hand. 14 years. Left hand.
Table 16. Steadiness of the hand. 15 years. Right hand.
Table 17. Steadiness of the hand. 15 years. Left hand.

Materials—Steadiness tester (see Whipple's Manual, Test 13, illustration and description), stop-watch, electric sounder, dry battery.

The steadiness tester is a metal plate set in a frame which supports it at an angle of 45° to the surface of the table. The plate contains nine round holes, arranged in two rows, four in the upper row and five in the lower. They decrease in size from the left hand one in the top row, which is a half-inch in diameter, to the right hand one in the lower row, which is 7/64 of an inch (see Whipple l. c.). The instrument has a binding post which is attached to a battery composed of three dry cells. The battery is attached at its other pole to one binding post of a telegraph sounder. To the other post of the sounder is attached a flexible wire, which leads to a metal pencil, having a wooden holder. The metal pencil is about the size and shape of an ordinary lead pencil, except that the metal rod projects two inches beyond the wooden holder.

Method of testing—The child was so placed with reference to the table that his elbow was on a level with its surface, and at such a distance from the instrument that when the pointer was held just inside one of the holes, the elbow was as far forward as the front surface of the body. The adjustments of height were made by means of a wooden platform large enough to hold the chair on which the child sat, and a series of wooden frames, each about an inch thick, which could be placed under it. The shorter the child, the more frames were needed under the platform. The same device was used to adjust the height of the child to the tapping-board, and to the card-sorting box.

When the child was correctly placed, the experimenter proceeded as follows:

"This is an instrument to measure the steadiness of your hand. When I put this metal pencil into one of these holes, and hold it still (illustrates), nothing happens, but as soon as my hand moves a little and makes the pointer touch the side of the hole, it causes that click (illustrates). I want you to put the pencil straight into the middle of this hole (pointing to the fourth one—the smallest in the top row) and see how still you can hold it—how few clicks you can make. Now try it to let me see if you hold the pencil properly (corrects any errors of position). Now that is right. I will tell you when to put the pencil in, and when to take it out, and don't mind the first few clicks when you put the pencil in. They don't count, anyway."

The stop-watch was started as the pencil was placed in the hole, but contacts were not counted during the first three seconds. Contacts were counted for fifteen seconds, making eighteen in all in which the pencil was held in each hole. The point arbitrarily selected as the limit of the child's capacity, was the smallest hole in which not more than twelve contacts were made.

It was necessary for the experimenter to watch the child very carefully during this test, since many errors were possible. Often, in spite of the preliminary warning, the pencil was put into the hole at an angle, and had to be straightened before the test could proceed. Sometimes it was withdrawn from the hole and held just barely in front of it instead of inside. Sometimes it was held against the side of the hole, thus causing a continuous contact, but only one sound. The same result could be accomplished by thrusting the pencil very far into the hole until it touched the back of the instrument. Each experimenter was trained to watch the child's hand continuously during the fifteen seconds of the test, except for necessary glances at the stop-watch. If any of these errors occurred, the test was stopped, the error pointed out, and the same hole tried again later.

The experimenter began each time with the fourth hole in the top row, using the child's right hand, and followed with a test of the left hand in the same hole. The hands were alternated

throughout the test, and the instrument moved back and forth across the table to bring the required hole opposite the hand to be tested. If more than twelve contacts were made in the fourth hole, the next trial was given in the third hole, a larger one. If the number of contacts was less than thirteen, but more than three, the next trial was given in the fifth hole, a smaller one. If the number of contacts was three or less, the fifth hole was omitted and the next trial was given in the sixth. The object in omitting a hole in case the number of contacts was very small, was to equalize the fatigue effects. If there was a sudden jump in the number of contacts made, or some disturbance occurred which affected a given test, the same hole was tried more than once. If everything went smoothly, and the progression from hole to hole was normal, each hole was tried but once with each hand.

Criticisms—The chief source of error in this piece of apparatus is that very light touches are sometimes not registered, either because one of the metal surfaces has become tarnished, or because the batteries begin to weaken. The inner surface of the holes, and the metal pencil should be kept polished, and the batteries should be renewed every few months.

Method of dealing with results—The results were recorded in terms of the smallest hole reached with each hand, and the number of contacts made in that hole, a number which was, according to the rule adopted, always twelve or less. The results were summed up as shown in the following tables and curves.

RESULTS

		Boys		Girls	
		14 years	15 years	14 years	15 years
	25 per.	H. 3 C. 8	H. 4 C. 12	H. 3 C. 2	H. 4 C. 9
	50 per.	H. 4 C. 11	H. 4 C. 7	H. 4 C. 8	H. 5 C. 12
	75 per.	H. 4 C. 4	H. 5 C. 9	H. 5 C. 10	H. 6 C. 11
Limits	Lower	H. 1 C. 1	H. 2 C. 10	H. 2 C. 11	H. 2 C. 8
Limits	Upper	H. 7 C. 7	H. 7 C. 6	H. 8 C. 10	H. 8 C. 9

Steadiness, hole and contacts. Right hand. Percentiles and limits

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 per.	H. 3 C. 12	H. 3 C. 9	H. 3 C. 10	H. 3 C. 2
50 per.	H. 3 C. 7	H. 4 C. 12	H. 3 C. 1	H. 4 C. 8
75 per.	H. 4 C. 10	H. 4 C. 7	H. 4 C. 8	H. 5 C. 11
Limits Lower	H. 1 C. 6	H. 1 C. 7	H. 1 C. 7	H. 1 C. 4
Limits Upper	H. 7 C. 10	H. 7 C. 9	H. 7 C. 10	H. 8 C. 12

Steadiness, hole and contacts. Left hand. Percentiles and limits

Correlation with School Grade.

Graph 14a. Boys. Right hand. 14 years.
Graph 14b. Girls. Right hand. 14 years.
Graph 16a. Boys. Right hand. 15 years.
Graph 16b. Girls. Right hand. 15 years.

Graphs are presented for the right hand only. None of the graphs except those for the right hand in the case of the girls show a correlation with the school grade in this test. On the whole, then, the test is not correlated with the school grade.

Comparison of Sex and School.

Graph 14c. Right hand. 14 years.
Graph 16c. Right hand. 15 years.

Sex—The graphs and percentiles for both years show that the girls are clearly superior to the boys in steadiness.

School—The public school children are on the whole superior to the parochial school children. The difference is marked in the case of the girls at both ages, but not evident in the case of the boys.

Age—Both boys and girls improve in steadiness from fourteen to fifteen years. The girls gain a little more than the boys.

Left-Handedness—As in the strength test, no account has been taken in the tables of left-handedness (see grip). There were in all, in the fourteen-year series, 48 boys and 31 girls whose left hands excelled the right in steadiness. Of the 48 boys, 22; and of the 31 girls, 14, were also left-handed in at least one of the

other tests, while 5 of the boys and 2 of the girls were left-handed in all three tests.

Of the 48 boys whose left hands were steadier than the right at fourteen years, 46 were retested at fifteen years. Of that 46, only 10 were again left-handed at fifteen years, while 28 who had not shown the phenomenon at fourteen years, showed superior steadiness of the left hand at fifteen years.

Of the 31 girls who had steadier left hands at fourteen years, 29 were retested. Of the 29, 5 also showed superiority of the left hand in steadiness at fifteen years, while 25 who had not shown a superior steadiness of the left hand at fourteen, did show it at fifteen.

In the fiften-year series there were 38 boys and 30 girls whose left hands were steadier than the right. Of the 38 boys, 14, and of the 30 girls, only 4 were left handed in one or both of the other tests. Of the 38 boys, only 3, and of the 30 girls, only 2 were left-handed in all three tests.

A superiority of the left hand in steadiness either at fourteen or at fifteen—not at both ages—appeared as the only indication of left-handedness in 36 boys and 24 girls. Since the corresponding figures in the case of grip were 103 boys and 64 girls, steadiness constitutes a far better indication of left-handedness than strength, though it is by no means infallible.

TABLE 14

Steadiness of the Hand. 14 years. Right Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Hole and Contact	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	1 12-0	0	0.	1	1.6	0	0.	0		0.		0	0.	0	0.	0	0.	0		0.	
	2 12-6	7		5		0		0				1		3		3		0			
	2 5-0	3	11.7	2	11.1	1	2.4	0		0.		1	4.8	1	7.0	0	7.0	0		0.	
	3 12-6	19		9		12		6	1			6		6		4		2	1		
	3 5-0	8	31.8	4	20.7	3	35.7	3	1	50.0		4	23.8	3	15.8	4	18.6	2		20.0	
	4 12-6	25		20		12		6				10		16		11		8	1		
	4 5-0	4	34.1	6	41.2	3	35.7	3		40.9		4	33.3	3	33.4	3	32.6	1		40.0	
	5 12-6	11		13		8		1				5		14		10		6			
	5 5-0	2	15.3	0	20.6	2	23.8	0		4.5		1	14.3	3	29.8	1	25.6	0		24.0	
	6 12-6	6		3		1		1				8		6		4		2	1		
	6 5-0	0	7.1	0	4.8	0	2.4	0		4.5		0	19.0	0	10.5	0	9.3	0		12.0	
	7 12-6	0		0		0		0				1		1		2		1			
	7 5—	0	0.	0	0.	0	0.	0				1	4.8	1	3.4	1	6.9	0		4.0	
	Total	85		63		42		20	2			42		57		43		22	3		
	Omitted	1		5		1		2	0			1		2		0		2	0		
Parochial School	1 12-0	0	0.	0	0.	0	0.	0	1	2.7		0	0.	0	0.	0	0.	0		0.	
	2 12-6	4		6		3		1				1		0		4		0			
	2 5-0	0	10.8	2	14.0	4	11.2	1		5.4		0	3.8	1	2.3	1	9.4	0		0.	
	3 12-6	8		10		13		7				5		14		9		1			
	3 5-0	6	37.8	5	26.3	4	27.0	2		24.4		2	26.9	5	44.1	4	24.5	4		15.1	
	4 12-6	11		22		18		16	1			10		14		18		13	1		
	4 5-0	1	32.4	6	49.1	6	38.1	1		48.6		3	50.0	1	34.8	4	41.5	3	2	57.6	
	5 12-6	4		2		10		3				5		3		8		7			
	5 5-0	0	10.8	0	3.5	0	15.9	1		10.8		0	19.2	0	7.0	0	15.1	0		21.2	
	6 12-6	2		3		5		2	1			0		4		2		2			
	6 5-0	0	5.4	0	5.3	0	7.9	0		8.1		0	0.	0	9.3	0	3.8	0		6.1	
	7 12-6	1		1		0		0				0		1		2		0			
	7 5—	0	2.7	0	1.8	0	0.0	0		0.		0	0.	0	2.3	1	5.7	0		0.	
	Total	37		57		63		34	3			26		43		53		30	3		
	Omitted	1		2		2		3	0			0		0		2		1	0		

TABLE 15

Steadiness of the Hand. 14 years. Left Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Hole and Contacts	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
PUBLIC SCHOOL	1 12-0	2	2.4	2	3.2	1	2.4	0		0.0		2	4.8	0	0.0	0	0.	0		0.	
	2 12-6	11	13.1	9	14.5	2	4.8	2		9.1		2	4.8	3	5.4	3	7.0	0		0.	
	2 5-0	9	10.7	2	3.2	1	2.4	2		9.1		1	2.4	4	7.1	1	2.3	1		4.2	
	3 12-6	30	35.7	20	32.3	20	47.6	7	2	40.9		6	14.3	14	25.0	11	25.6	7	2	37.5	
	3 5-0	8	9.5	4	6.4	4	9.5	2		9.1		3	7.1	7	12.5	7	16.3	4		16.7	
	4 12-6	16	19.0	18	29.0	11	26.2	5		22.7		17	40.5	15	26.8	9	20.9	5	1	25.0	
	4 5-0	0	0.0	3	4.8	1	2.4	1		4.5		4	9.5	1	1.8	2	4.6	0		0.0	
	5 12-6	6	7.1	3	4.8	1	2.4	1		4.5		3	7.1	8	14.3	7	16.3	2		8.3	
	5 5-0	1	1.2	0	0.0	0	0.0	0				1	2.4	2	3.6	0	0.0	0		0.0	
	6 12-6	1	1.2	1	1.6	0	0.0	0				2	4.8	2	3.6	3	7.0	1		4.2	
	6 5-0	0		0		0	0.0	0				0		0		0		1		4.2	
	7 12-6	0		0		1	2.4	0				1	2.4	0		0		0			
	7 5-0	0		0		0		0				0		0		0		0			
	Total	84		62		42		20	2			42		56		43		21	3		
	Omitted	2		6		1		2				1		3		0		3			
PAROCHIAL SCHOOL	1 12-0	0		2	3.5	2	3.2	1	1	5.4		3	11.5	2	4.6	1	1.9	0		0.0	
	2 12-6	4	11.1	6	10.5	9	14.3	5		13.5		2	7.7	6	13.9	9	17.0	0		0.0	
	2 5-0	1	2.8	2	3.5	3	4.8	3		8.1		1	3.8	3	7.0	2	3.8	0	1	3.0	
	3 12-6	14	38.9	19	33.3	16	25.4	10		27.0		9	34.6	11	25.6	11	20.8	11	1	36.4	
	3 5-0	5	13.9	6	10.5	6	9.5	5		13.5		0	0.0	5	11.6	6	11.3	5		15.1	
	4 12-6	6	16.7	17	29.8	17	27.0	8	1	24.3		7	26.9	10	23.3	19	35.8	10		30.3	
	4 5-0	1	2.8	2	3.5	6	9.5	1		2.7		2	7.7	0	0.0	2	3.8	1	1	6.1	
	5 12-6	2	5.6	2	3.5	4	6.4	1		2.7		2	7.7	4	9.3	1	1.9	2		6.1	
	5 5-0	2	5.6	0	0.0	0		0		0.0		0		0	0.0	0		0		0.0	
	6 12-6	0	0.0	1	1.7	0		0	1	2.7		0		2	4.6	2	3.8	1		3.0	
	6 5-0	1	2.8	0		0		0				0		0		0					
	7 12-6	0		0		0		0				0		0		0					
	7 5-0	0		0		0		0				0		0		0					
	Total	36		57		63		34	3			26		43		53		30	3		
	Omitted	2		2		2		3	0			0		0		2		1			

TABLE 16

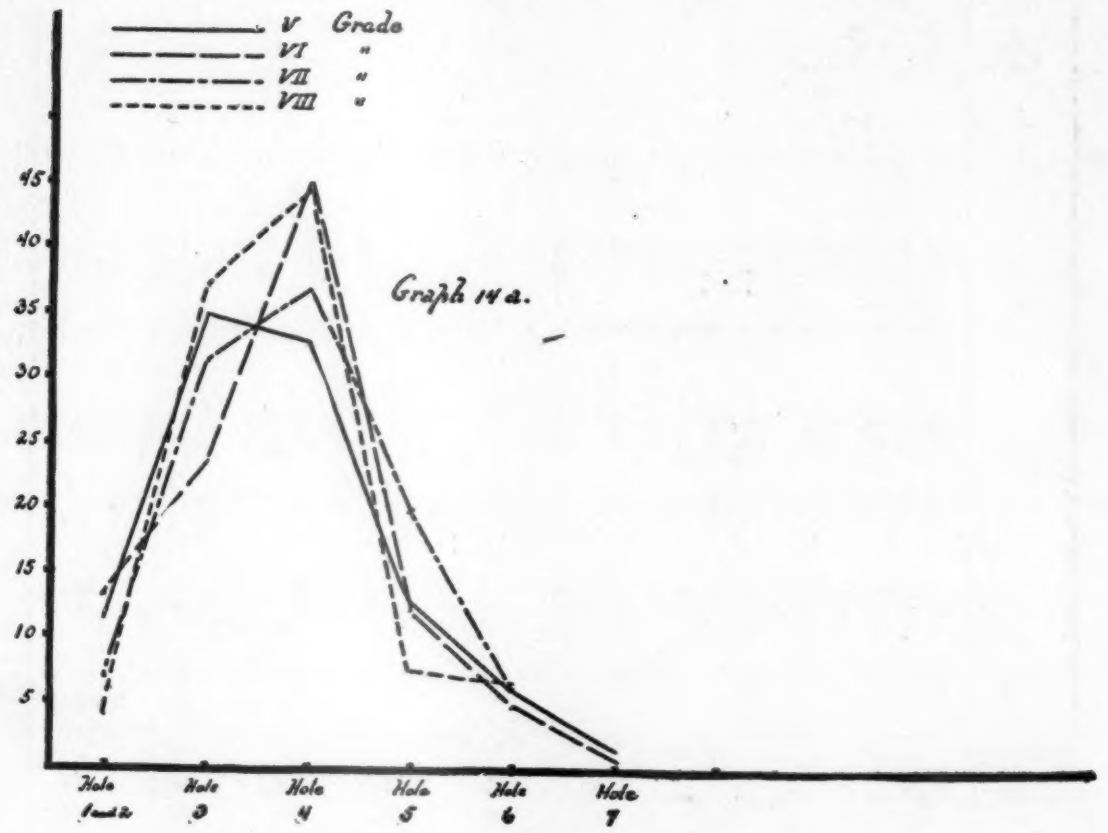
Steadiness of the Hand. 15 years. Right Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
Public School	Hole and Contacts	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
	$1^{0}-1^{12}$	0		0		0		0				0		0		0		0			
	$2^{6}-2^{12}$	3		3		2		0				0		1		1		0			
	$2^{0}-2^{5}$	2	6.6	1	7.1	0	5.	1		5.3		0	0.0	0	2.0	1	5.9	0		0.0	
	$3^{6}-3^{12}$	12		7		1		3				1		3		1		1			
	$3^{0}-3^{5}$	5	22.4	2	15.8	2	7.5	2		26.3		1	6.7	1	7.8	1	5.9	0		4.8	
	$4^{6}-4^{12}$	23		13		13		4				9		9		10		4	1		
	$4^{0}-4^{5}$	9	42.1	7	35.1	3	40.	0	1	26.3		1	33.3	5	27.4	2	35.3	2		33.3	
	$5^{6}-5^{12}$	12		14		10		5				9		14		4		3			
	$5^{0}-5^{5}$	2	18.4	0	24.5	0	25.	1		31.6		0	30.	4	35.3	0	11.8	1		19.0	
	$6^{6}-6^{12}$	4		8		8		2				3		10		10		5			
	$6^{0}-6^{5}$	0	5.3	1	15.8	0	20.			10.5		0	10.	2	23.5	1	32.3	0		23.8	
	$7^{6}-7^{12}$	4		1		1						6		2		2		3			
	$7^{0}-7^{5}$	0	5.3	0	1.7	0	2.5					0	20.	0	3.9	0	5.9	0		14.3	
	$8^{0}-8^{12}$	0		0		0						0		0		1	2.9	1		4.8	
	Total	76		57		40		18	1			30		51		34		20	1		
	Omitted	4		5		3		4	1			6		2		2					
Parochial School	$1^{0}-1^{12}$	0		0		0		0				0		0		0		0			
	$2^{6}-2^{12}$	0		3		0		1				1		0		0		0			
	$2^{0}-2^{5}$	1	2.9	0	6.	3	5.4	0		3.2		0	4.3	0	0.0	0	0.0	0		0.0	
	$3^{6}-3^{12}$	4		8		6		2				4		1		1		0			
	$3^{0}-3^{5}$	2	17.1	1	18.	2	14.5	2		12.9		0	17.4	2	8.3	1	4.1	0		0.0	
	$4^{6}-4^{12}$	10		20		23		13				5		18		15		9	1		
	$4^{0}-4^{5}$	2	34.3	1	42.	1	43.6	1		45.2		2	30.4	0	50.	6	42.9	1		40.7	
	$5^{6}-5^{12}$	10		10		11		7				6		8		13		6	1		
	$5^{0}-5^{5}$	1	31.4	1	22.	2	23.6	0		22.6		0	26.1	1	25.	0	26.5	1		29.6	
	$6^{6}-6^{12}$	5		3		6		3				4		4		11		1			
	$6^{0}-6^{5}$	0	14.3	0	6.	0	10.9	1		12.7		0	17.4	0	11.1	0	22.4	1		7.4	
	$7^{6}-7^{12}$	0		3		1		1				1		2		2		3	1		
	$7^{0}-7^{5}$	0		0	6.	0	1.8	0		3.2		0	4.3	0	5.6	0	4.1	0		14.8	
	$8^{0}-8^{12}$	0		0		0		0				0		0		0		2		7.4	
	Total	35		50		55		31				23		36		49		24	3		
	Ohitted			3		7		2				1		1		2		2			

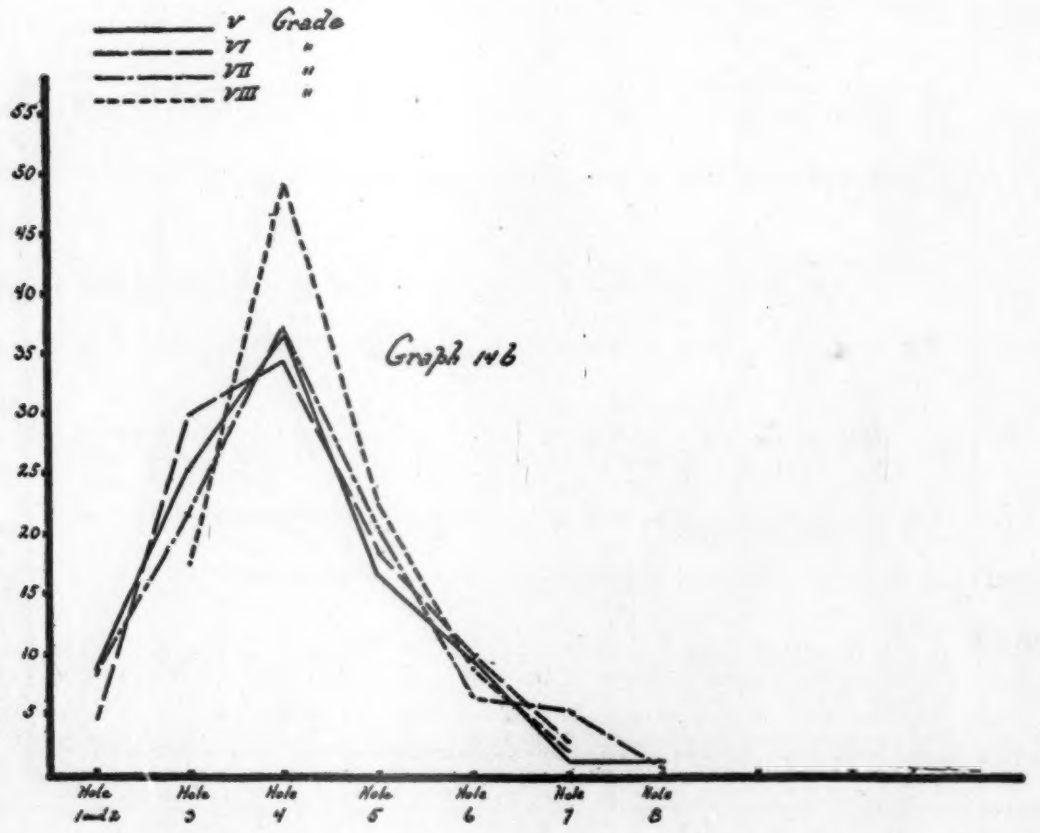
TABLE 17

Steadiness of the Hand. 15 years. Left Hand

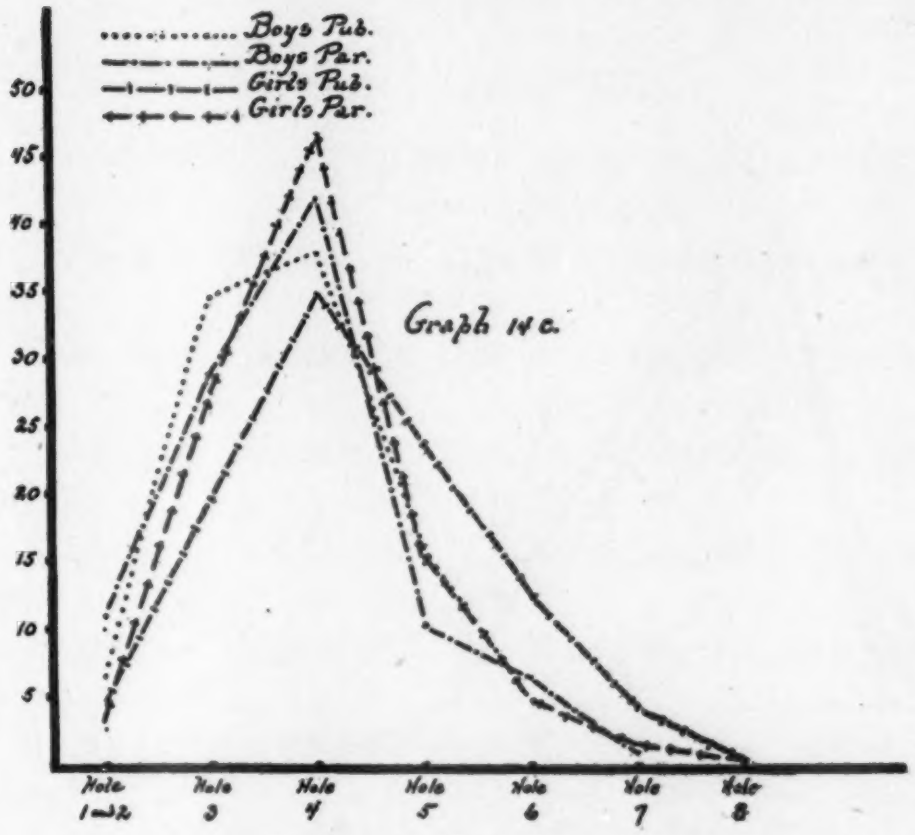
School	Grade	Boys V No.	Boys V %	Boys VI No.	Boys VI %	Boys VII No.	Boys VII %	Boys VIII	Boys IX	Boys VIII and IX %	Girls V No.	Girls V %	Girls VI No.	Girls VI %	Girls VII No.	Girls VII %	Girls VIII	Girls IX	Girls VIII and IX %
Public School	Hole and Contacts	0		0		0		0		0.0	0	0.0	0	0.0	2	5.9	0		0.0
	$1^{0}-1^{12}$	7	9.2	4	7.1	3	7.5	2		10.5	1	3.3	3	5.9	1	2.9	0		0.0
	$2^{6}-2^{12}$	4	5.3	1	1.7	1	2.5	0		0.0	0	0.0	0	0.0	0	0.0	0		0.0
	$2^{0}-2^{5}$	17	22.4	11	19.3	9	22.5	3	1	21.0	3	9.9	5	9.8	2	5.9	2	1	14.3
	$3^{6}-3^{12}$	7	9.2	7	12.3	2	5.0	5		26.3	1	3.3	1	2.0	4	11.8	4		19.0
	$3^{0}-3^{5}$	25	32.9	18	31.6	16	40.0	6		31.6	14	46.7	20	39.2	12	35.3	5		23.8
	$4^{6}-4^{12}$	3	3.9	4	7.1	1	2.5	0		0.0	1	3.3	4	7.8	4	11.8	0		00.0
	$4^{0}-4^{5}$	10	13.2	8	14.0	6	15.0	2		10.5	2	6.6	14	27.4	5	14.7	4		19.0
	$5^{6}-5^{12}$	1	1.3	0	0.0	0	0.0				0	0.0	1	2.0	0	0.0	0		0.0
	$5^{0}-5^{5}$	1	1.3	3	5.3	2	5.0				6	20.0	3	5.9	1	2.9	2		9.5
	$6^{6}-6^{12}$	0	0.0	0	0.0						1	3.3			0	0.0	1		4.8
	$6^{0}-6^{5}$	1	1.3	1	1.7						1	3.3			3	8.8	2		9.5
	$7^{6}-7^{12}$																		
	$7^{0}-7^{5}$																		
	$8^{0}-8^{12}$																		
	Total	76		57		40		18	1		30		51		34		20	1	
	Omitted	4		5		3		4	1		6		2		2				
Parochial School	$1^{0}-1^{12}$	1	2.8	0	0.	0	0.0	0		0.0	0	0.0	0	0.0	0	0.0	0		0.0
	$2^{6}-2^{12}$	1	2.8	3	6.	3	5.3	3		9.7	3	13.0	0	0.0	2	4.1	0		0.0
	$2^{0}-2^{5}$	1	2.8	2	4.	3	5.3	3		9.7	1	4.3	0	0.0	2	4.1	0		0.0
	$3^{6}-3^{12}$	9	25.7	12	24.	15	26.8	8		25.8	4	17.4	9	25.0	11	22.4	4		14.8
	$3^{0}-3^{5}$	4	11.4	3	6.	1	1.8	3		9.7	3	13.0	2	5.5	2	4.1	1		3.7
	$4^{6}-4^{12}$	10	28.6	20	40.	20	35.7	8		25.8	4	17.4	13	36.1	16	32.7	7	2	33.3
	$4^{0}-4^{5}$	2	5.7	4	8.	2	3.6	2		6.4	0	0.0	2	5.5	3	6.1	4		14.8
	$5^{6}-5^{12}$	4	11.4	5	10.	4	7.1	4		12.9	6	26.1	9	25.0	9	18.4	4		14.8
	$5^{0}-5^{5}$	0	0.0	0	0.	0					0	0.0		0.0	0	0.0	0		0.0
	$6^{6}-6^{12}$	3	8.6	0	0.	7	12.5				1	4.3		0.0	1	2.0	3	1	14.8
	$6^{0}-6^{5}$			0	0.	0					1	4.3		0.0	0	0.0	0		
	$7^{6}-7^{12}$			1	2.	1	1.8						1	2.8	3	6.1	0		
	$7^{0}-7^{5}$																0		
	$8^{0}-8^{12}$																1		3.7
	Total	35		50		56		31			23		36		49		24	3	
	Omitted			3		6		2			1		1		2		2		



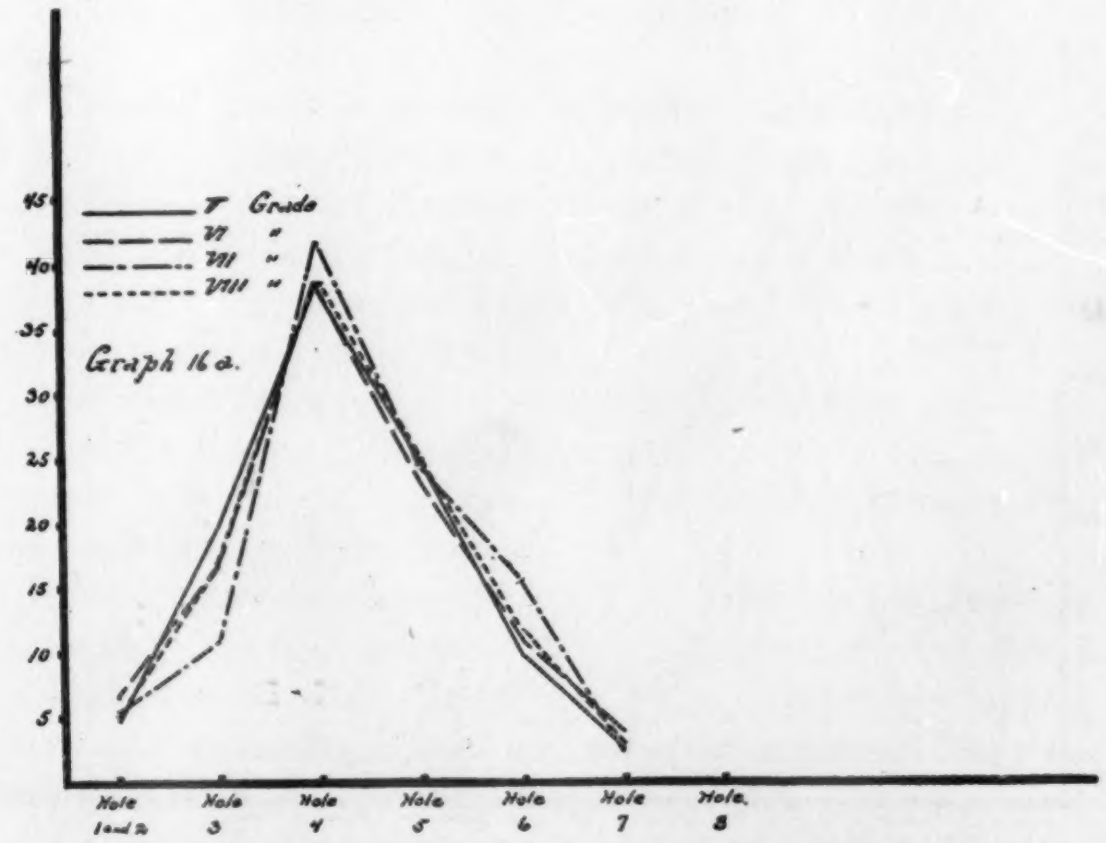
STEADINESS OF THE HAND. 15 YEARS. RIGHT HAND. BOYS.



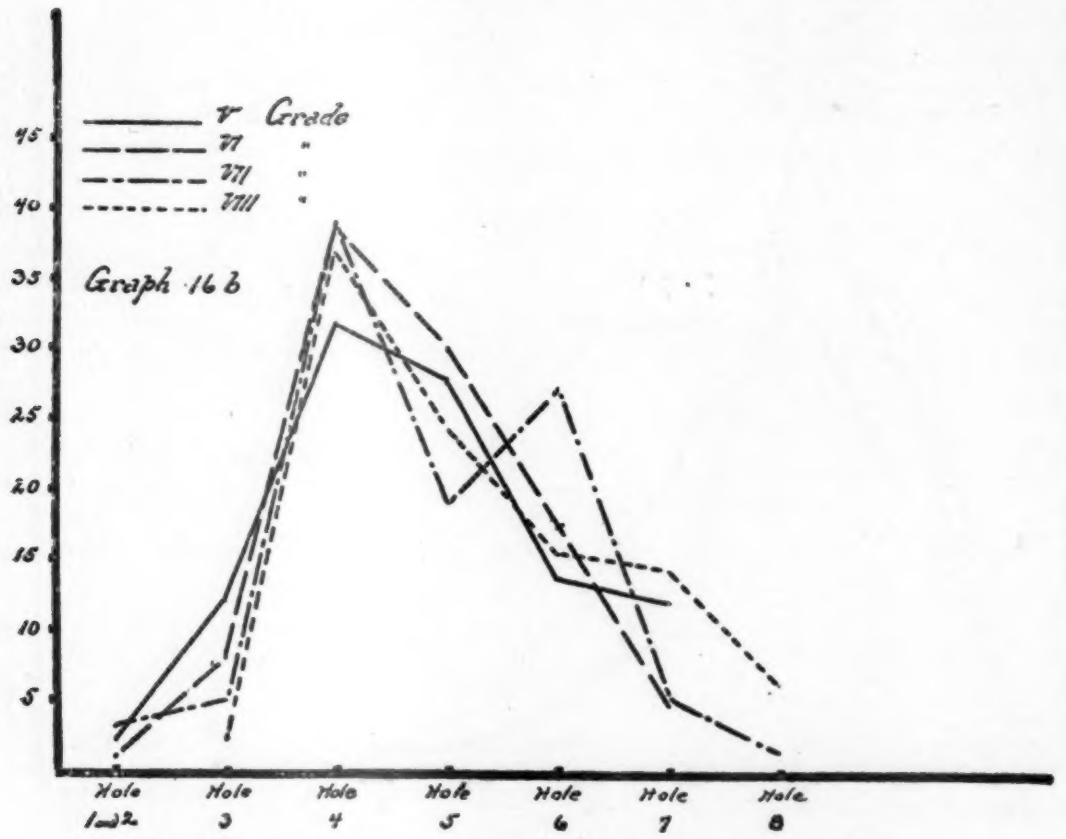
STEADINESS OF THE HAND. 14 YEARS. RIGHT HAND. GIRLS.



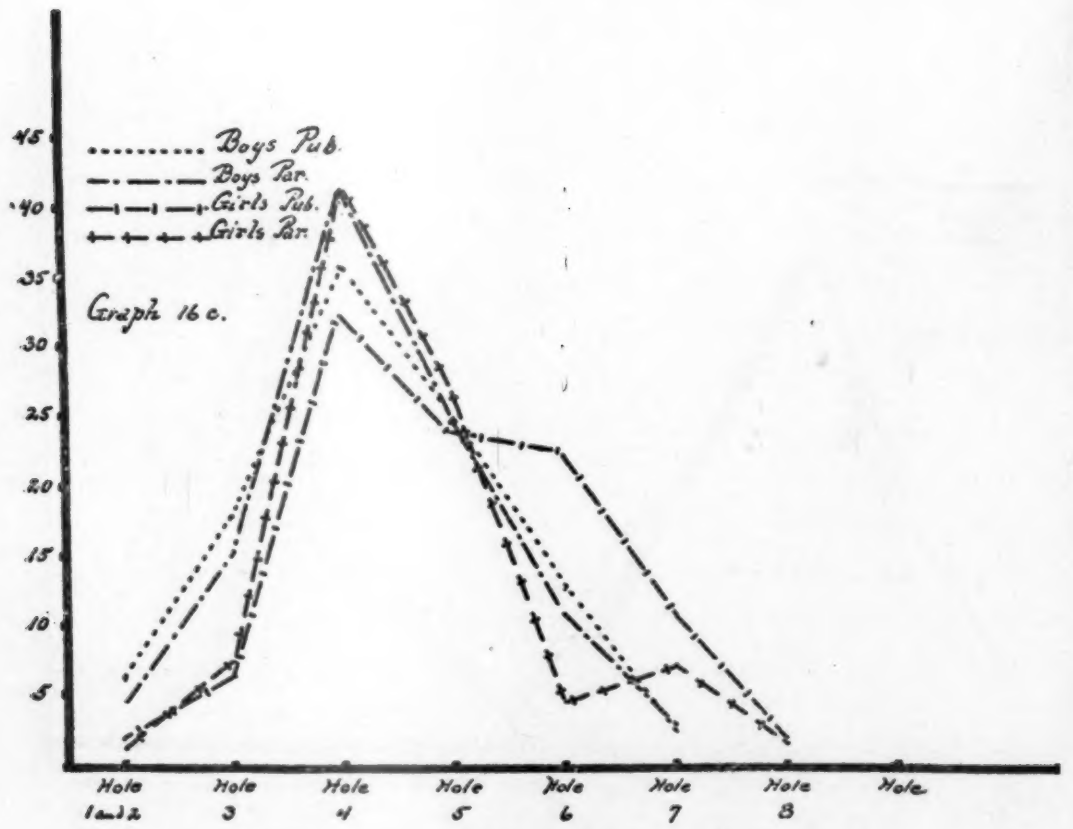
STEADINESS OF THE HAND. 14 YEARS. RIGHT HAND.



STEADINESS OF THE HAND. 15 YEARS. RIGHT HAND. BOYS.



STEADINESS OF THE HAND. 15 YEARS. RIGHT HAND. GIRLS.



STEADINESS OF THE HAND. 15 YEARS. RIGHT HAND.

Section VIII

RAPIDITY OF MOVEMENT OF THE HAND. (TAPPING TEST)

Index of Fatigue

Table 18. Number of Taps in 30 seconds. 14 years. Right hand.

Table 19. Number of Taps in 30 seconds. 15 years. Right hand.

Table 20. Number of Taps in 30 seconds. 14 years. Left hand.

Table 21. Number of Taps in 30 seconds. 15 years. Left hand.

Table 22. Number of Taps in one minute. 14 years. Right hand.

Table 23. Number of Taps in one minute. 15 years. Right hand.

Table 24. Number of Taps in one minute. 14 years. Left hand.

Table 25. Number of Taps in one minute. 15 years. Left hand.

Table 26. Index of fatigue. 14 years. Right hand.

Table 27. Index of fatigue. 15 years. Right hand.

Table 28. Index of fatigue. 14 years. Left hand.

Table 29. Index of fatigue. 15 years. Left hand.

Materials—Tapping board (see Whipple's Manual, Test 10), electric enumerator, stop-watch.

Criticism—The accuracy of recording contacts with an electric enumerator has been frequently questioned. We found our instrument accurate for any rate of speed which obtained either from children, or from adults.

Method of administering the test—The child was adjusted with reference to the tapping board at such a height that when sitting up straight on his chair, his forearm rested easily on the tapping board (for method of adjustment, see steadiness test). The experimenter then explained the test as follows:

"I want you to rest your arm on the board this way (does it) so that it touches the board all the way from the elbow to the wrist,

and then see how fast you can tap with this instrument on this metal plate, this way, just moving your hand from the wrist (does it). Do you see that pointer move once every time this pencil touches the plate, so that by watching it, I can tell how fast you are tapping? Be sure not to lift your wrist from the board while you are tapping. Now you try it. (Child is allowed to tap a very few seconds—method criticized if wrong). Now hold your hand all ready, and the instant I say "now," begin to tap, and tap just as fast as you possibly can until I tell you to stop."

The experimenter then took the reading of the dial, placed the stop-watch in his right hand, and gave the signal to start. He started the watch when the child's hand moved down for the first tap, and then took the readings of the dial when the second-hand passed the 15-, 30-, 45- and 60-second marks.

Criticism—This method of taking the readings is undoubtedly open to criticism. To read one moving point by another is a difficult and uncertain operation. None of the experimenters was allowed to give the test until he had had a period of practice, and had tested his ability by taking readings simultaneously with a skilled person. Because of these sources of error, small differences between one record and another cannot be considered significant, but large differences certainly are.

Method of dealing with results—The number of taps for each quarter of a minute was obtained by subtracting each reading of the dial from the following one. The number of taps for the first and second half-minutes, and for the whole minutes were then added up. As an index of fatigue we calculated what per cent of taps in the first fifteen seconds had been lost in the last fifteen seconds. The justice of considering this value as an indication of the amount of fatigue, depends upon whether or not the individual being tested was putting forth his best effort throughout the test. It is obviously impossible to be sure of this in any case. The instructions were given in a way to call out a maximum effort for speed, but of course not every child responded. There are even a few negative indices in the series. This defect is one common to all tests for fatigue.

The following measurements for each hand have been summed up in tables and curves: The taps of the first half-minute, of the whole minute, and the index of fatigue.

RESULTS

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	155	164	157	161
50 perc.	170	177	167	171
75 perc.	182	189	178	181
Q	13.5	12.5	10.5	10.0
Limits—				
Lower	120	118	96	105
Upper	226	300	225	234

Number of taps in 30 seconds. Right hand. Percentiles and limits

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	129	135	127	132
50 perc.	140	147	139	144
75 perc.	154	159	153	156
Q	12.5	12.0	13.0	12.0
Limits—				
Lower	85	110	86	91
Upper	206	212	198	201

Number of taps in 30 seconds. Left hand. Percentiles and limits

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	297	309	297	305
50 perc.	321	334	315	325
75 perc.	334	358	338	345
Q	18.5	24.5	20.5	20.0
Limits—				
Lower	219	204	216	201
Upper	443	571	430	440

Number of taps in one minute. Right hand. Percentiles and limits

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	241	254	243	251
50 perc.	266	276	263	272
75 perc.	290	298	287	295
Q	24.5	22.0	22.0	22.0
Limits—				
Lower	179	203	167	175
Upper	391	402	372	372

Number of taps in one minute. Left hand. Percentiles and limits

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	12.9	12.6	12.8	11.8
50 perc.	16.9	16.6	16.6	16.0
75 perc.	22.2	21.3	20.9	19.8
Q	4.6	4.3	4.0	4.0
Limits—				
Lower	neg. index	neg. index	neg. index	neg. index
Upper	37.8	42.7	38.9	35.8

Index of fatigue in percents. Right hand. Percentiles and limits

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	12.5	12.9	12.7	13.4
50 perc.	17.8	17.8	17.9	17.7
75 perc.	23.0	21.0	21.9	21.9
Q	5.2	4.0	4.6	4.2
Limits—				
Lower	neg. index	neg. index	neg. index	neg. index
Upper	50.0	38.2	44.3	40.3%

Index of fatigue in percents. Left hand. Percentiles and limits

Correlations with school grades.

Graphs for total number of taps in one minute. Right hand.

Graph 22a—Boys, 14 years.

Graph 22b—Girls, 14 years.
Graph 23a—Boys, 15 years.
Graph 23b—Girls, 15 years.
Graphs for the Index of Fatigue. Right hand.
Graph 26a—Boys, 14 years.
Graph 26b—Girls, 14 years.
Graph 27a—Boys, 15 years.
Graph 27b—Girls, 15 years.

Although the graphs have been drawn for all the measures of this test, it does not seem worth while to publish them all. We have selected those for the right hand, based on the total number of taps for one minute, and those for the same hand on the index of fatigue, as samples. They will give an idea of the amount of correlation—or lack of correlation—involved.

All of the graphs for speed for the boys—those of both hands, and of both ages—those for thirty and those for sixty seconds, show a positive correlation with school grade. It is not very marked, and not always perfectly consistent for every graph, but it is undoubtedly present throughout.

The graphs for the girls are not so consistent. Those for the number of taps in thirty seconds, all show a slight positive correlation with school grade. The graphs for the total number of taps in a minute show very little correlation, except the superiority of the eighth grade girls.

The graphs for the index of fatigue, also show a positive correlation with school grade in the case of the boys, though it is not apparent in the one for the right hand at fifteen years. In this graph, too, however, the eighth grade boys show less fatigue than the other grades. One can make the generalization, therefore, that the boys in the upper grades not only tap faster than those in the lower grades, but do so with less sign of fatigue.

The graphs for the girls show no positive correlation of fatigue with school grade. In fact in so far as any tendency is discernible, it is in the direction of a negative correlation. There are two graphs in which the fifth grade shows least fatigue, and in which the eighth grade shows most fatigue. Since the thirty-second graphs show a slight correlation with

school grade, and the sixty-second graphs less, the interpretation of the series of facts seems to be as follows. The girls in the upper grades probably put more initial effort into the test than those in the lower grades, but they were not able to keep up the pace. As a result, they tend to show more fatigue, and come out very little better in speed for the whole minute than the girls in the lower grades. The eighth grade group of girls, however, display superior speed in all the graphs except the one in which they show greatest fatigue. On the whole, therefore, the eighth grade group of girls stands out as displaying greater speed than the others, with no greater fatigue.

Comparisons of Sex and School.

Graphs for the total number of taps in one minute. Right hand.

Graph 22c—14 years.

Graph 23c—15 years.

Graphs for the Index of Fatigue. Right hand.

Graph 26c—14 years.

Graph 27c—15 years.

Sex—The percentiles for both ages show a slightly greater speed on the part of the boys.

The graphs regarded from the point of view of sex alone, also show a slight superiority of speed in boys, but the most striking thing about them is the great superiority of the group of public school boys,—a superiority sufficiently large to counterbalance the inferiority of the parochial group. At fifteen years the greater speed of the boys is much more evident, both in the percentiles and in the graphs. While the group of public school boys is still in advance of all the others, it is not quite so far ahead as it was at fourteen.

In the index of fatigue, the difference of sex is very small. To bring all the percentiles and graphs into consideration, we can say that the girls show a trifle less fatigue than the boys. The test is one which appealed to the boys—as a measure of physical prowess—more than it did to the girls, and probably called forth more effort on their part—hence somewhat more fatigue.

School—The graphs for speed show a small though con-

sistent superiority of the public school group over that of the parochial school. Those for the index of fatigue show no distinguishable difference between the two groups. The public school children, therefore, display greater speed, with no greater fatigue.

Age—There is an undoubted superiority in speed of the fifteen-year group over the fourteen-year. While both sexes gain in speed from fourteen to fifteen, the boys gain considerably more than the girls. This gain is accompanied by a slight decrease in the index of fatigue, so that one can say there is a decided increase in efficiency in the performance of the test the second year.

Left-handedness—In the fourteen-year series, there are 29 boys, and 22 girls whose left hands are more rapid than the right. Of the 29 boys, 15; and of the 22 girls, 13, are also left-handed in one or both of the other tests, while 5 boys and 2 girls are left-handed in all three tests.

Of the 29 boys, 26 were retested for tapping at fifteen years. Of the 26, 12 were also superior with the left hand at fifteen years, while 9 boys who had not shown superior speed with the left hand at fourteen years, did so at fifteen.

Of the 22 girls, 20 were retested for tapping at fifteen years. Of the 20, 11 were also left-handed in tapping at fifteen years, while 10 girls who had shown no superiority of speed with the left hand at fourteen years, did show it at fifteen years.

At fifteen years there were 21 boys, and 21 girls whose left hands were faster than the right. Of the 21 boys, 12; and of the 21 girls, 7 were also left-handed in one or both of the other tests, while 3 boys and 2 girls were left-handed in all three of the fifteen-year tests. (Compare sections on Strength and Steadiness.)

A superiority of the left hand in speed either at fourteen or at fifteen—not at both ages—appeared as the only indication of left-handedness in but 10 boys and 11 girls. The corresponding figures for strength were 103 boys and 64 girls, and for steadiness, 36 boys and 24 girls. A superior rapidity of the left hand, therefore, constitutes a far more reliable indication of left-handedness than superior steadiness or superior strength.

TABLE 18

Number of Taps in 30 seconds. 14 years. Right Hand

School	Grade	Boys V		VI		VII		VIII	IX	VIII and IX	Girls V		VI		VII		VIII	IX	VIII and IX
	No. of Taps	No.	%	No.	%	No.	%	No.	No.	%	No.	%	No.	%	No.	%	No.	No.	%
Public School	120—	0		0		0		0			0		1	1.8	0		0		
	121 - 130	1	1.3	0	0.0	0	0.0	0			0		0	0.0	0		0		
	131 - 140	1	1.3	3	5.0	1	2.8	0			1	2.8	0	0.0	3	8.3	0		
	141 - 150	11	14.7	9	15.0	2	5.5	1		4.8	3	8.3	10	18.2	4	11.1	0		
	151 - 160	10	13.3	4	6.7	4	11.1	5	1	28.6	8	22.2	10	18.2	7	19.4	4	2	23.1
	161 - 170	10	13.3	9	15.0	8	22.2	3		14.3	14	38.9	8	14.5	7	19.4	8	1	34.6
	171 - 180	18	24.0	14	23.2	10	27.8	0		0.0	9	25.0	13	23.6	5	13.9	5		19.2
	181 - 190	18	24.0	11	18.3	5	13.9	7		33.3	1	2.8	6	10.9	3	8.3	4		15.4
	191 - 200	5	6.7	4	6.7	2	5.5	2	1	14.3	0		4	7.3	7	19.4	2		7.7
	201 - 210	1	1.3	2	3.3	2	5.5	0		0.0	0		2	3.6	0		0		
	210+	0		4	6.7	2	5.5	1		4.8	0		1	1.8	0		0		
	Total	75		60		36		19	2		36		55		36		23	3	
	Omitted	11		8		7		3	0		7		4		7		1	0	
Parochial School	120—	0		1	1.9	0		0			1	4.2	0		0		0		
	121 - 130	0		1	1.9	1	1.8	0		0.	1	4.2	0	.0	1	2.0	0		
	131 - 140.	2	5.4	4	7.5	2	3.7	3		8.1	0	0.0	2	5.3	2	4.0	0		
	141 - 150	3	8.1	4	7.5	7	13.0	3	1	10.8	2	8.3	2	5.3	4	8.0	0	1	3.2
	151 - 160	8	21.6	15	28.3	6	11.1	7		18.9	2	8.3	8	21.0	6	12.0	4	1	16.1
	161 - 170	12	32.4	6	11.3	12	22.2	5		13.5	9	37.5	9	23.7	18	36.0	6		19.4
	171 - 180	5	13.5	13	24.5	15	27.8	8	1	24.3	4	16.7	10	26.3	10	20.0	9	1	32.3
	181 - 190	4	10.8	6	11.3	6	11.1	4	1	13.5	3	12.5	5	13.2	8	16.0	7		22.6
	191 - 200	2	5.4	2	3.8	3	5.5	4		10.8	2	8.3	1	2.6	1	2.0	0		0.0
	201 - 210	0	0.0	1	1.9	2	3.7	0			0		0	0.0	0		1		3.2
	210+	1	2.7	0		0		0			0		1	2.6	0		1		3.2
	Total	37		53		54		34	3		24		38		50		28	3	
	Omitted	1		6		11		3	0		2		5		5		3	0	

TABLE 19

Number of Taps in 30 seconds. 15 years. Right Hand

School	Grade	Boys									Girls								
		V		VI		VII		VIII	IX	VIII and IX	V		VI		VII		VIII	IX	VIII and IX
	No. of Taps	No.	%	No.	%	No.	%	No.	No.	%	No.	%	No.	%	No.	%	No.	No.	%
Public School	111 - 120	0		0		0		0			0		0		0		0		
	121 - 130	1	1.3	1	1.6	0		0			0		1	1.9	0		0		
	131 - 140	2	2.6	2	3.3	0		0			1	2.8	0	0.0	1	2.8	0		
	141 - 150	1	1.3	4	6.5	2	4.6	0			0	0.0	5	9.6	1	2.8	0		
	151 - 160	3	3.9	3	4.9	4	9.3	2		8.3	4	11.4	8	15.4	6	16.7	1		4.8
	161 - 170	16	20.7	6	9.8	6	13.9	6		25.0	10	28.6	11	21.1	8	22.2	6	1	33.3
	171 - 180	20	26.0	13	21.3	9	20.9	3		12.5	13	37.1	14	26.9	9	25.0	7		33.3
	181 - 190	17	22.0	21	34.4	7	16.3	5		20.8	6	17.1	1	1.9	7	19.4	3		14.3
	191 - 200	11	14.3	2	3.3	7	16.3	2	1	12.5	1	2.8	8	15.4	4	11.1	1		4.8
	201 - 210	3	3.9	7	11.5	6	13.9	2	0	8.3	0		2	3.8	0		2		9.5
	210+	3	3.9	2	3.3	2	4.6	2	1	12.5	0		2	3.8	0		0		
	Total	77		61		43		22	2		35		52		36		20	1	
	Omitted	3		1		0		0	0		1		1		0				
Parochial School	111 - 120	0		0		0		1		3.1	2	8.7	1	2.7	0		0		
	121 - 130	0		1	2.0	1	1.6	0		0.0	0	0.0	0	0.0	0		1		3.7
	131 - 140	0		0	0.0	2	3.3	0		0.0	0	0.0	3	8.1	1	2.0	0		0.0
	141 - 150	3	8.6	9	17.6	3	4.9	4		12.5	2	8.7	2	5.4	2	4.0	0	1	3.7
	151 - 160	3	8.6	5	9.8	9	14.7	1		3.1	3	13.0	7	18.9	5	10.0	2	1	11.1
	161 - 170	8	22.8	7	13.7	12	19.7	6		18.7	6	26.1	8	21.6	14	28.0	2	1	11.1
	171 - 180	10	28.6	8	15.7	12	19.7	6		18.7	6	26.1	5	13.5	15	30.0	12		44.4
	181 - 190	4	11.4	12	23.5	11	18.0	8		25.0	1	4.3	6	16.2	5	10.0	2		7.4
	191 - 200	2	5.7	4	7.8	3	4.9	3		9.4	1	4.3	3	8.1	3	6.0	3		11.1
	201 - 210	3	8.6	2	3.9	2	3.3	3		9.4	2	8.7	2	5.4	3	6.0	2		7.4
	210+	2	5.7	3	5.9	6	9.8	0			0		0		2	4.0	0		
	Total	35		51		61		32			23		37		50		24	3	
	Omitted	0		2		1		1			1		0		1		2	0	

TABLE 20

Number of Taps in 30 seconds. 14 years. Left Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	No. of Taps	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100—	0		2	3.4	0		1		4.8		0		2	3.6	3	8.3	0			
	101 - 110	5	6.7	2	3.4	1	2.8	0		0.0		0		0	0.0	2	5.6	0			
	111 - 120	6	8.0	6	10.2	2	5.5	1	1	9.5		3	8.3	7	12.7	4	11.1	2			7.7
	121 - 130	11	14.7	5	8.5	6	16.7	0		0.0		7	19.4	8	14.5	4	11.1	2	1		11.5
	131 - 140	18	24.0	12	20.3	4	11.1	4	1	23.8		11	30.6	11	20.0	1	2.8	8			30.8
	141 - 150	14	18.7	11	18.6	8	22.2	5		23.8		8	22.2	11	20.0	6	16.7	4	1		19.2
	151 - 160	11	14.7	13	22.0	5	13.9	5		23.8		2	5.6	6	10.9	11	30.6	5			19.2
	161 - 170	6	8.0	6	10.2	3	8.3	3		14.3		4	11.1	5	9.1	3	8.3	2			7.7
	171 - 180	3	4.0	2	3.4	5	13.9	0				0	0.0	4	7.3	2	5.6	0			0.0
	181 - 190	1	1.3	0		2	5.5	0				1	2.8	1	1.8	0		0	1		3.8
	191 - 200	0		0		0		0				0		0		0		0			
	201+	0		0		0		0				0		0		0		0			
	Total	75		59		36		19	2			36		55		36		23	3		
	Omitted	11		9		7		3	0			7		4		7		1			
Parochial School	100—	0		1	1.9	0		1		2.9		1	4.2	1	2.7	1	2.0	0			
	101 - 110	0		3	5.7	3	5.8	0		0.0		1	4.2	0	0.0	2	4.0	0			
	111 - 120	4	10.8	2	3.8	1	1.9	3		8.6		4	16.7	2	5.4	1	2.0	1			3.2
	121 - 130	6	16.2	6	11.3	11	21.1	7	1	22.9		4	16.7	7	18.9	11	22.0	4	1		16.1
	131 - 140	12	32.4	16	30.2	14	26.9	5	1	17.1		5	20.8	11	29.7	12	24.0	5	1		19.4
	141 - 150	5	13.5	9	17.0	11	21.1	4		11.4		4	16.7	6	16.2	7	14.0	8			25.8
	151 - 160	6	16.2	10	18.9	6	11.6	6		17.1		3	12.5	6	16.2	7	14.0	7	1		25.8
	161 - 170	2	5.4	5	9.4	5	9.6	4		11.4		1	4.2	2	5.4	3	6.0	0			0.0
	171 - 180	2	5.4	0	0.0	0	0.0	2	1	8.6		1	4.2	0	0.0	6	12.0	1			3.2
	181 - 190	0		0	0.0	0	0.0	0				0		1	2.7	0		1			3.2
	191 - 200	0		1	1.9	0	0.0	0				0		1	2.7	0		1			3.2
	201+	0		0		1	1.9	0				0		0		0		0			
	Total	37		53		52		32	3			24		37		50		28	3		
	Omitted	1		6		13		5	0			2		6		5		3			

TABLE 21

Number of Taps in 30 seconds. 15 years. Left Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX		VIII and IX	V		VI		VII		VIII	IX		VIII and IX
	No. of Taps	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	101 - 110	0	0.0	1	1.6	0	0.0	0		0.0		1	2.8	1	1.9	1	2.8	0			
	111 - 120	7	9.2	3	4.9	0	0.0	1		4.3		0	0.0	4	7.7	2	5.5	0			
	121 - 130	10	13.2	6	9.8	6	13.9	0		0.0		1	2.8	8	15.4	3	8.3	1			5.
	131 - 140	11	14.5	10	16.4	5	11.6	3		13.0		11	30.5	13	25.0	6	16.7	5	1		30.
	141 - 150	17	22.4	20	32.8	5	11.6	8		34.8		10	27.8	9	17.3	11	30.5	5			25.
	151 - 160	16	21.0	8	13.1	12	27.9	3	1	17.4		8	22.2	7	13.5	9	25.0	4			20.
	161 - 170	12	15.8	7	11.5	10	23.3	4	1	21.7		0	0.0	3	5.8	3	8.3	4			20.
	171 - 180	2	2.6	3	4.9	1	2.3	2		8.7		4	11.1	4	7.7	1	2.8				
	181 - 190	0	0.0	3	4.9	3	7.0					1	2.8	2	3.8						
	191 - 200	1	1.3	0		1	2.3					0	0.0	1	1.9						
	Total	76		61		43		21	2			36		52		36		19	1		
	Omitted	4		1										1				1			
Parochial School	101 - 110	0	0.0	0	0.0	0	0.0	0		0.0		0	0.0	1	2.7	2	4.	0			0.0
	111 - 120	1	2.8	2	3.8	4	6.7	1		3.1		5	20.	4	10.8	3	6.	0			0.0
	121 - 130	5	14.3	7	13.5	9	15.0	4		12.5		2	8.	6	16.2	9	18.	2			7.7
	131 - 140	6	17.1	11	21.1	13	21.7	4		12.5		6	24.	4	10.8	8	16.	7	2		34.6
	141 - 150	6	17.1	10	19.2	12	20.0	9		28.1		6	24.	6	16.2	11	22.	6			23.1
	151 - 160	11	31.4	9	17.3	9	15.0	9		28.1		2	8.	8	21.6	7	14.	5			19.2
	161 - 170	4	11.4	10	19.2	6	10.0	4		12.5		2	8.	4	10.8	5	10.	3	1		15.4
	171 - 180	1	2.8	2	3.8	2	3.8	1		3.1		2	8.	2	5.4	4	8.				
	181 - 190	0	0.0	0	0.0	3	5.0	0						0	0.0	0	0.				
	191 - 200	1	2.8	1	1.9	2	3.3	0						2	5.4	1	2.				
	Total	35		52		60		32				25		37		50		23	3		
	Omitted			1		2		1				1				1		3			

TABLE 22

Number of Taps in one minute. 14 years. Right Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	No. of Taps	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	201 - 220	0		0		0		0				0		1		0		0			
	221 - 240	0	0.	0	0.	0	0.	0		0.		0	0.	0	1.8	0	0.	0		0.	
	241 - 260	3		2		0		0				0		0		4		0			
	261 - 280	7	13.3	9	18.7	1	2.8	0		0.		5	13.5	4	7.3	2	16.6	0		0.	
	281 - 300	8		6		2		5				5		15		4		4	1		
	301 - 320	15	30.7	8	23.8	9	30.5	2	1	38.1		14	51.3	8	41.8	11	41.6	8	2	57.7	
	321 - 340	20		13		9		2				10		14		5		4			
	341 - 360	14	45.4	11	40.6	8	47.2	7		42.7		3	35.1	7	38.1	5	27.8	4		30.8	
	361 - 380	8		4		5		2	1			0		3		4		3			
	381 - 400	0	10.7	6	17.0	2	19.4	1		19.1		0	0.	3	10.8	1	13.9	0		11.5	
	Total	75		59		36		19	2			37		55		36		23	3		
	Omitted	11		9		7		3	0			6		4		7		1			
Parochial School	201 - 220	1		0		0		0				0		0		0		1			
	221 - 240	0	2.7	0	0.	0	0.	0		0.		0	0.	1	2.7	0	0.	1		6.4	
	241 - 260	1		3		1		1				1		0		1		0			
	261 - 280	3	10.8	6	17.0	8	16.6	3		11.5		1	8.6	2	5.4	4	9.8	0	1	3.2	
	281 - 300	5		13		5		6	1			4		8		8		3	1		
	301 - 320	14	51.3	12	47.1	15	37.1	4		31.4		7	47.8	12	54.0	20	54.9	4	1	29.0	
	321 - 340	6		7		15		12	1			4		7		7		8			
	341 - 360	3	24.3	8	28.3	7	40.8	3		45.7		3	30.4	6	35.1	9	31.3	7		48.4	
	361 - 380	3		4		1		3	1			3		1		2		3			
	381 - 400	1	10.8	0	7.5	2	5.5	0		11.4		0	13.0	0	2.7	0	3.9	1		12.9	
	Total	37		53		54		32	3			23		37		51		28	3		
	Omitted	1		6		11		5	0			3		6		4		3	0		

TABLE 23

Number of Taps in one minute. 15 years. Right Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	No. of Taps	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	240—	0		0		0		0	1	4.2		1	2.9	1	1.9	0		0			
	241 - 260	3		2		0		0				0		1		0		0			
	261 - 280	0	3.9	4	9.8	1	2.3	0		0.0		1	2.9	2	5.8	0	0.0	0			
	281 - 300	3		5		5		2				3		7		7		0			
	301 - 320	19	28.6	9	22.9	7	27.9	4		25.0		7	28.6	14	40.4	8	41.7	6	1	33.3	
	321 - 340	19		10		8		4				15		12		10		6			
	341 - 360	17	46.8	17	44.2	7	34.9	6		41.6		8	65.7	8	38.5	7	47.2	4		47.6	
	361 - 380	11		8		9		3						4		4		3			
	381 - 400	3	18.2	4	19.7	4	30.2	1	1	20.8				2	11.5		11.1	1		19.0	
	401 - 420	0		1		2		1						0							
	421 - 440	2		0		0		1						1							
	441+	0	2.6	1	3.3	0	4.6			8.3				0	1.9						
	Total	77		61		43		22	2			35		52		36		20	1		
	Omitted	3		1								1		1							
Parochial School	240—	1	2.9	0		1	1.6	1		3.1		1	4.3	2	5.4	1	2.	0			
	241 - 260	0		0		1		0				0		2		0		1			
	261 - 280	4	11.4	2	3.9	2	4.9	1		3.1		1	4.3	3	13.5	2	4.	0	1	7.4	
	281 - 300	1		13		8		4				5		3		6		0			
	301 - 320	8	25.7	8	41.2	11	31.1	6		31.2		5	43.5	10	35.1	13	38.	5	2	25.9	
	321 - 340	9		8		14		5				6		6		15		9			
	341 - 360	5	40.	13	41.2	11	41.0	7		37.5		1	30.4	5	29.7	6	42.	4		48.1	
	361 - 380	4		4		7		5				3		4		2		4			
	381 - 400	1	14.3	1	9.8	3	16.4	3		25.		1	17.4	2	16.2	5	14.	1		18.5	
	401 - 420	1		2		2		0				0		0		0		0			
	421 - 440	0		0		0		0				0		0		0		0			
	441+	1	5.7	0	3.9	1	4.9	0				0		0		0		0			
	Total	35		51		61		32				23		37		50		24	3		
	Omitted			2		1		1				1				1		2			

TABLE 24

Number of Taps in one minute. 14 years. Left Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	No. of Taps	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	200—	4	5.3	2	3.4	0	0.0	0		0.0		0	0.	2	3.6	3	8.3	0		0.	
	201 - 220	4		3		2		1				2		4		4		1			
	221 - 240	13	22.6	8	18.6	6	22.2	1		10.0		6	21.6	8	21.8	3	19.4	3		15.3	
	241 - 260	10		10		4		2	1			11		11		3		7	1		
	261 - 280	20	40.0	11	35.5	7	30.5	6		45.0		9	54.0	14	45.4	6	25.0	6	1	57.7	
	281 - 300	15		15		7		3				4		6		11		5			
	301 - 320	3	24.0	9	40.6	4	30.5	6		45.0		3	18.9	6	21.8	5	44.4	1		23.0	
	321 - 340	3		1		3		0				1		3		1		0			
	341 - 360	3	8.0	0	1.7	2	13.8	0		0.0		1	5.4	0	5.5	0	2.8	0	1	3.8	
	361 - 380	0		0		0		0				0		1		0		0			
	381 - 400	0	0.0	0	0.0	1	2.8	0		0.0		0	0.0	0	1.8	0	0.0	0		0.0	
	Total	75		59		36		19	1			37		55		36		23	3		
	Omitted	11		9		7		3	1			6		4		7		1	0		
Parochial School	200—	1	2.7	2	3.8	1	1.9	1		2.8		1	4.2	1	2.7	1	2.0	0		0.0	
	201 - 220	2		2		1		2				4		1		2		0			
	221 - 240	8	27.0	7	17.0	11	23.0	7		25.7		3	29.2	5	16.2	7	17.6	2		6.4	
	241 - 260	9		16		14		3	1			8		12		13		7	2		
	261 - 280	8	45.9	11	50.9	11	48.0	8	1	37.1		4	50.0	9	56.7	12	49.0	7		51.6	
	281 - 300	4		10		7		4				1		4		7		7	1		
	301 - 320	3	18.9	3	24.6	3	19.3	5		25.7		2	12.5	2	16.2	4	21.5	3		35.5	
	321 - 340	1		1		3		1	1			1		1		3		0			
	341 - 360	1	5.4	0	1.9	0	5.8	1		8.5		0	4.2	1	5.4	2	9.8	0		0.0	
	361 - 380	0		1		1		0				0		1		0		2			
	381 - 400	0	0.0	0	1.9	0	1.9	0		0.0		0	0.0	0	2.7	0	0.0	0		6.4	
	Total	37		53		52		32	3			24		37		51		28	3		
	Omitted	1		6		13		5	0			2		6		4		3	0		

TABLE 25

Number of Taps in one minute. 15 years. Left Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	No. of Taps	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	200—	0		0		0		0				0		0		0		0			
	201 - 220	4		3		0		0				0		3		2		0			
	221 - 240	10	18.5	5	13.1	3	7.0	1		4.3		0	0.0	6	17.3	3	13.8	3		15.0	
	241 - 260	8		8		6		2				7		14		4		0	1		
	261 - 280	22	39.4	20	45.9	7	30.2	6	1	39.1		11	49.9	10	46.1	11	41.6	8		45.0	
	281 - 300	15		11		12		6				12		9		10		3			
	301 - 320	11	34.2	12	37.7	8	46.5	2	1	39.1		2	38.8	5	26.9	6	44.5	4		35.0	
	321 - 340	3		1		2		4				3		4				0			
	341 - 360	3	7.8	1	3.2	3	11.6			17.4		1	11.1	1	9.6			1		5.0	
	361 - 380					2															
	381+						4.6														
	Total	76		61		43		21	2			36		52		36		19	1		
	Omitted	4		1										1				1			
Parochial School	200—	0		0		0		0				0		1	2.7	2	4.0	0			
	201 - 220	0		3		1		1				2		3		1		0			
	221 - 240	7	20.0	4	13.5	8	14.9	1		6.2		4	26.1	5	21.6	4	10.0	1		3.8	
	241 - 260	9		9		15		7				6		5		9		6	2		
	261 - 280	4	37.1	12	40.4	14	48.3	6		40.6		7	56.5	6	29.7	15	48.0	6		53.9	
	281 - 300	8		15		9		10				0		7		9		6			
	301 - 320	5	37.1	7	42.3	5	23.3	5		46.8		2	8.7	6	35.1	8	34.0	4	1	42.3	
	321 - 340	1		1		5		1				1		2		1					
	341 - 360	0	2.8	0	1.9	2	11.6	0		3.1		1	8.6	1	8.1	0	2.0			0.0	
	361 - 380	0		0		1		1						1		1					
	380+	1	2.8	1	1.9	0	1.7			3.1					2.7		2.0				
	Total	35		52		60		32				23		37		50		23	3		
	Omitted			1		2		1				1				1		3			

TABLE 26

Index of Fatigue. 14 years. Right Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX		VIII and IX	V		VI		VII		VIII	IX		VIII and IX
	%	No.	%	No.	%	No.	%	No.	No.		%	No.	%	No.	%	No.	%	No.	No.		%
Public School	Neg. Index	0		0		1		1				0		0		0		0			
	5.0—	1		2		2		0	1			0		3		2		0			
	5.1-7.5	2		2		2		1				2		4		1		2			
	7.6-10.0	7	13.3	2	10.2	1	17.1	0			14.3	5	19.5	0	12.7	2	14.0	1			15.3
	10.1-12.5	6		2		3		3				4		5		8		4			
	12.6-15.0	10	21.3	10	20.4	6	25.7	2			23.8	6	27.8	11	29.1	4	33.3	2	1		26.9
	15.1-17.5	12		9		1		6				4		10		4		6			
	17.6-20.0	9	28.0	11	33.9	9	28.6	3			42.9	5	25.0	7	30.9	2	16.7	4			38.4
	20.1-22.5	4		4		5		1	1			2		6		4		2			
	22.6-25.0	6	13.3	8	20.4	3	22.8	0			9.5	3	13.9	6	21.8	1	13.9	0	1		11.5
	25.1-27.5	7		7		2		1				4		1		4		2			
	27.6-30.0	3	13.3	1	13.6	0	5.7	0			4.8	0	11.1	1	3.6	2	16.7	0			7.7
	30.1-32.5	4		0		0		1				1		0		1		0			
	32.6-35.0	2	8.0	1	1.7	0	0.0	0			4.8	0	2.8	1	1.8	0	2.8	0			0.0
	35.1-37.5	2		0		0		0				0		0		1		0			
	37.6-40.0	0		0		0		0				0		0		0		0			
	40.0+	0	2.7	0	0.0	0	0.0	0			0.0	0	0.0	0	0.0	0	2.8	0			0.0
	Total	75		59		35		19	2			36		55		36		23	3		
	Omitted	11		9		8		3	0			7		4		7		1	0		
Parochial School	Neg. Index	0		2		1		0				1		0		1		0	0		
	5.0—	0		3		1		0				1		2		0		1			
	5.0-7.5	0		2		2		1				2		1		3		0			
	7.6-10.0	4	10.8	2	17.0	5	16.7	3			10.8	3	29.2	1	10.8	0	7.8	2			9.7
	10.1-12.5	6		7		4		3	2			1		1		4		3			
	12.6-15.0	1	18.9	9	30.2	12	29.6	5			27.0	3	16.7	6	18.9	12	31.4	5	1		29.0
	15.1-17.5	9		5		9		7	1			1		5		9		5			
	17.6-20.0	6	40.5	4	17.0	6	27.8	4			32.4	2	12.5	8	35.1	10	37.2	6	1		38.7
	20.1-22.5	1		4		7		3				5		8		5		1			
	22.6-25.0	7	21.6	6	18.9	3	18.5	5			21.6	2	29.2	2	27.0	2	13.7	1			6.4
	25.1-27.5	1		3		3		0				0		0		2		3			
	27.6-30.0	0	2.7	3	11.3	0	5.5	3			8.1	1	4.2	1	2.7	0	3.9	1			12.9
	30.1-32.5	2		0		0		0				2		1		1		0	1		
	32.6-35.0	0	5.4	2	3.8	0	0.0	0			0.0	0	8.3	0	2.7	0	2.0	0			3.2
	35.1-37.5	0		1		0		0				0		0		1		0			
	37.6-40.0	0		0		1		0				0		1		1		0			
	40.0+	0	0.0	0	1.9	0	1.8	0			0.0	0	0.0	0	2.7	0	3.9	0			0.0
	Total	37		53		54		34	3			24		37		51		28	3		
	Omitted	1		6		11		3	0			2		6		4		3	0		

TABLE 27

Index of Fatigue. 15 years. Right Hand

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
PUBLIC SCHOOL	5.0—	2		5		2		0				1		1		3		1			
	5.1-7.5	2		4		0		1				1		2		3		3			
	7.6-10.0	4	10.4	2	18.0	4	14.0	3		16.7		0	5.7	2	9.6	2	22.2	2		28.6	
	10.1-12.5	7		2		4		4				3		6		2		1			
	12.6-15.0	11	23.4	11	21.3	8	27.9	3		29.2		12	42.8	6	23.1	9	30.6	2		14.3	
	15.1-17.5	13		9		7		2				6		9		4		4			
	17.6-20.0	11	31.2	11	32.8	6	30.2	4	1	29.2		3	25.7	10	36.5	5	25.0	2	1	33.3	
	20.1-22.5	11		5		2		0	1			3		6		4		3			
	22.6-25.0	8	24.7	2	11.5	3	11.6	3		16.7		3	17.1	4	19.2	2	16.7	2		23.8	
	25.1-27.5	3		2		3		1				3		2		1					
	27.6-30.0	1	5.2	4	9.8	4	16.3	1		8.3			8.6	0	3.8	1	5.6				
	30.1-32.5	2		1										3							
	32.6-35.0	0	2.6	1	3.3									0	5.8						
	35.1-37.5	1		1										1							
	37.6-40.0	1	2.6	1	3.3										1.9						
	40.1 and 40.1+	0		0																	
	Total	77		61		43		22	2			35		52		36		20	1		
	Omitted	3		1								1		1							
PAROCHIAL SCHOOL	5.0—	2		1		4		3				2		1		2		1			
	5.1-7.5	1		2		3		3				0		3		2		0			
	7.6 10.0	3	17.1	2	9.8	2	14.7	2		25.0		4	26.1	4	21.6	5	18.	1	1	11.5	
	10.1-12.5	5		7		6		2				4		4		7		4	1		
	12.6-15.0	6	31.4	10	33.3	9	24.6	4		18.7		2	26.1	5	24.3	2	18.	4		34.6	
	15.1-17.5	5		5		11		4				3		10		10		1	1		
	17.6-20.0	6	31.4	5	19.6	7	29.5	2		18.7		2	21.7	5	40.5	10	40.	9		42.3	
	20.1-22.5	5		7		6		8				2		4		6		2			
	22.6-25.0	1	17.1	5	23.5	6	19.7	2		31.2		3	21.7	0	10.8	4	20.	0		7.7	
	25.1-27.5	0		1		4		2				1		1		1		1			
	27.6-30.0	0		3	7.8	1	8.2			6.2			4.3		2.7	0	2.			3.8	
	30.1-32.5	0		2		0										0					
	32.6-35.0	0		0	3.9	2	3.3									1	2.				
	35.1-37.5	0		1																	
	37.6-40.0	0		0																	
	40.1 and 40.1+	1	2.9	0	2.0																
	Omitted	35		51		61		32	0			23		37		50		23	3		
	Total			2		1		1				1				1		3			

TABLE 28

Index of Fatigue. 14 years. Left Hand

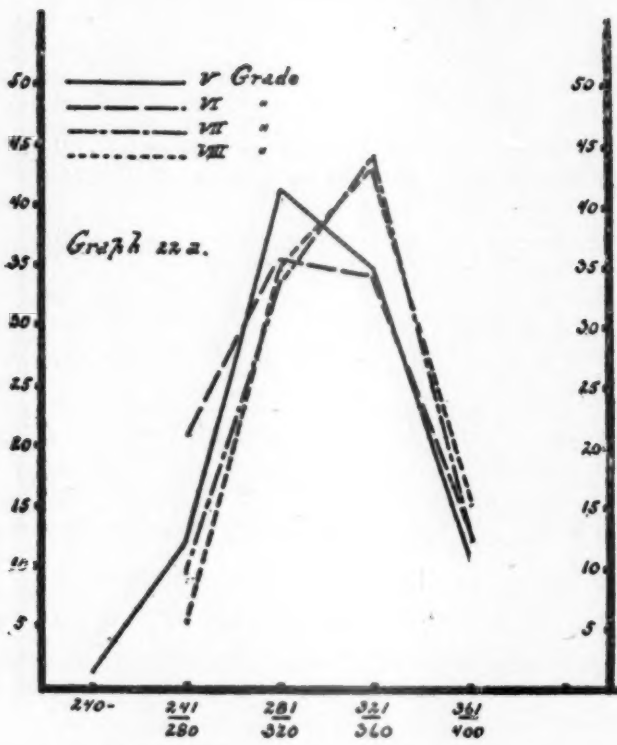
School	Grade	Boys V No.	Boys V %	Boys VI No.	Boys VI %	Boys VII No.	Boys VII %	Boys VIII	Boys IX	Boys VIII and IX %	Girls V No.	Girls V %	Girls VI No.	Girls VI %	Girls VII No.	Girls VII %	Girls VIII	Girls IX	Girls VIII and IX %
Public School	Neg.	1		1		1		0			0		0		1		0		
	5.0—	5		0		0		4			1		1		2		0	1	
	5.1-7.5	3		2		1		1			0		4		3		2		
	7.6-10.0	3	16.0	3	10.1	3	13.9	1		28.6	1	5.5	4	16.3	4	27.8	2		19.2
	10.1-12.5	8		10		3		2	1		7		1		4		1		
	12.6-15.0	4	16.0	5	25.4	7	27.7	2		23.8	2	25.0	8	16.3	3	19.4	3	1	19.2
	15.1-17.5	11		7		1		1			5		6		4		1		
	17.6-20.0	10	28.0	6	22.0	6	19.5	2		14.3	3	22.2	5	20.0	1	13.9	5		26.9
	20.1-22.5	11		7		3		0	1		8		13		4		1		
	22.6-25.0	8	25.3	10	28.8	3	16.6	3		19.0	5	36.1	3	29.1	5	25.0	5	1	23.1
	25.1-27.5	7		5		5		1			1		4		2		1		
	27.6-30.0	3	13.3	2	11.8	1	16.7	2		14.3	1	5.5	4	14.5	1	8.3	1		7.7
	30.1-32.5	0		1		0		0			1		0		1		0		
	32.6-35.0	1	1.3	0	1.7	0	0.0	0		0.0	1	5.5	1	1.8	0	2.8	1		3.8
	35.1-37.5	0		0		1		0			0		0		0		0		
	37.6-40.0	0		0		0		0			0		0		1		0		
	40.1+	0	0.0	0	0.0	1	5.6	0		0.0	0	0.0	1	1.8	0	2.8	0		0.0
	Total	75		59		36		19	2		36		55		36		23	3	
	Omitted	11		9		7		3	0		7		4		7		1	0	
Parochial School	Neg.	0		0		1		0			1		0		0		0		
	5.0—	4		1		3		0	1		1		1		2		0		
	5.1-7.5	0		0		4		0			0		1		3		2		
	7.6-10.0	1	13.5	4	9.4	6	26.9	2		8.6	0	8.3	5	18.9	4	18.0	2		12.5
	10.1-12.5	2		6		0		4			2		1		5		2	1	
	12.6-15.0	4	16.2	5	20.7	3	5.8	1	1	17.1	1	12.5	3	10.8	7	24.0	2		15.6
	15.1-17.5	4		12		10		6	1		6		2		7		7		
	17.6-20.0	8	32.4	6	34.0	8	34.6	6		37.1	7	54.2	12	37.8	8	30.0	9	2	56.2
	20.1-22.5	2		5		6		4			2		5		2		4		
	22.6-25.0	4	16.2	5	18.9	4	19.2	5		25.7	1	12.5	3	21.6	4	12.0	0		12.5
	25.1-27.5	3		5		5		3			2		2		4		0		
	27.6-30.0	4	18.9	4	17.0	1	11.5	1		11.4	0	8.3	0	5.4	2	12.0	1		3.1
	30.1-32.5	0		0		1		0			0		1		1		0		
	32.6-35.0	1	2.7	0	0.0	0	1.9	0		0.0	1	4.2	0	2.7	0	2.0	0		0.0
	35.1-37.5	0		0		0		0			0		0		0		0		
	37.6-40.0	0		0		0		0			0		1		1		0		
	40.1+	0	0.0	0	0.0	0		0		0.0	0	0.0	0	2.7	0	2.0	0		0.0
	Total	37		53		52		32	3		24		37		50		29	3	
	Omitted	1		6		13		5	0		2		6		5		2	0	

TABLE 29

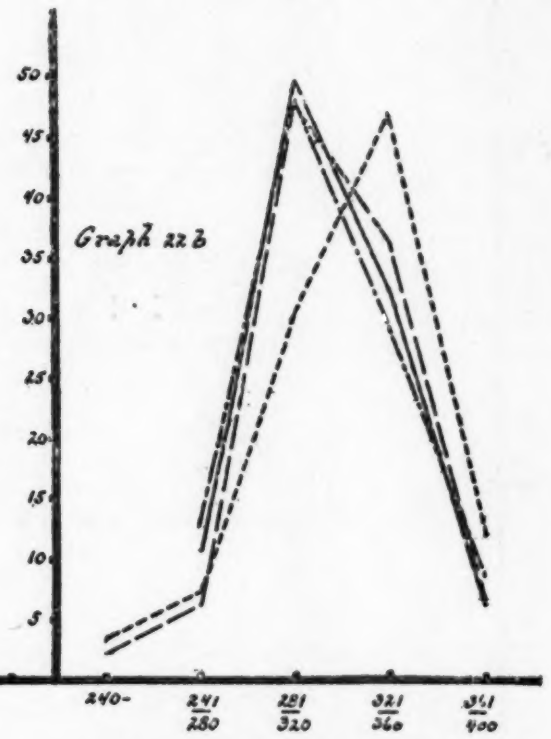
TABLE 29

Index of Fatigue. 15 years. Left Hand

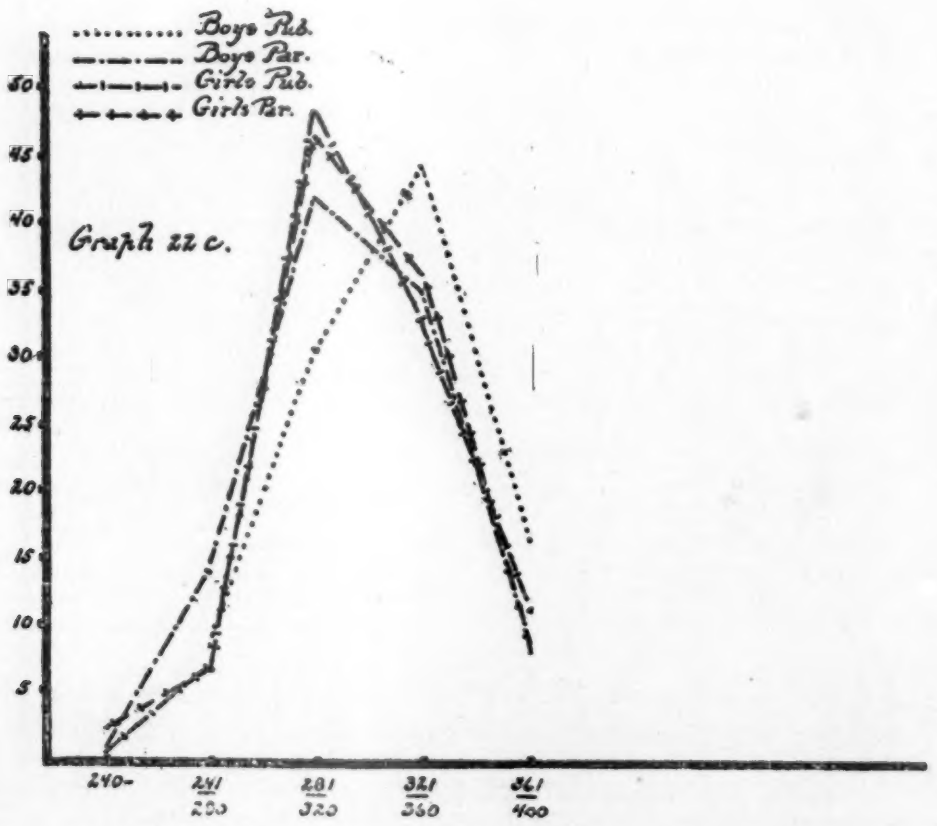
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
PUBLIC SCHOOL	Negative	0		1		0		0				0		1		0		1			
	5.0—	5		1		3		2				1		5		2		2			
	5.1-7.5	0		0		3		0				2		2		1		1			
	7.6-10.0	4	11.9	1	4.8	5	25.6	4		26.1		2	13.8	3	21.1	0	8.3	1			25.
	10.1-12.5	7		5		3		0				3		4		2		2			
	12.6-15.0	7	18.4	10	24.6	6	20.9	1		4.3		8	30.5	4	15.4	6	22.2	1			15.
	15.1-17.5	11		8		3		4	1			6		7		6		1	1		
	17.6-20.0	9	26.3	11	31.1	5	18.6	2		30.4		4	27.8	9	30.8	5	30.6	2			20.
	20.1-22.5	10		10		7		3				6		8		5		4			
	22.6-25.0	7	22.4	3	21.3	4	25.6	4		30.4		3	25.0	4	23.1	5	27.8	2			30.
	25.1-27.5	11		6		2		0	1			1		0		1		1			
	27.6-30.0	2	17.1	2	13.1	2	9.2	1		8.6			2.8	3	5.8	0	2.8	0			5.
	30.1-32.5	2		2										0		2		0			
	32.6-35.0	1	3.9	1	4.9									2	3.8	1	8.3	0			00.
	35.1-37.5																	0			
	37.6-40.0																	0			00.
	40.1-42.5																	1			5.
	Total	76		61		43		21	2			36		52		36		19	1		
	Omitted	4		1				1						1							
PAROCHIAL SCHOOL	Negative	0		0		2		0				1		0		0		0			
	5.0—	1		1		2		1				2		1		6		0			
	5.1-7.5	1		4		3		0				1		3		1		0			
	7.6-10.0	1	8.4	5	19.2	3	16.6	4		15.6		2	26.0	3	18.9	3	20.	3			11.5
	10.1-12.5	4		2		8		1				3		3		8		1			
	12.6-15.0	3	20.0	8	19.2	9	28.3	6		21.8		1	17.4	7	27.0	6	28.	5	1		26.9
	15.1-17.5	4		5		6		5				2		5		9		3	1		
	17.6-20.0	11	42.8	12	32.7	9	25.0	5		31.2		2	17.4	7	32.4	9	36.	7	1		46.2
	20.1-22.5	2		3		9		4				3		5		3		3			
	22.6-25.0	4	17.1	5	15.4	6	25.0	4		25.0		2	21.7	1	16.2	1	8.	1			15.3
	25.1-27.5	0		2		2		0				4		1		3					
	30.1-32.5	2	5.7	3	9.6	0	3.3	1		3.1			17.4	1	5.4	0	6.				
	32.6-35.0	2		1		0		1								1					
	35.1-37.5		5.7	0	1.9	1	1.7			3.1							2.				
	37.6-40.0			0																	
	40.1-42.5			1	1.9																
	420.1+																				
	Total	35		52		60		32				23		37		50		23	3		
	Omitted			1		2		1				1				1					



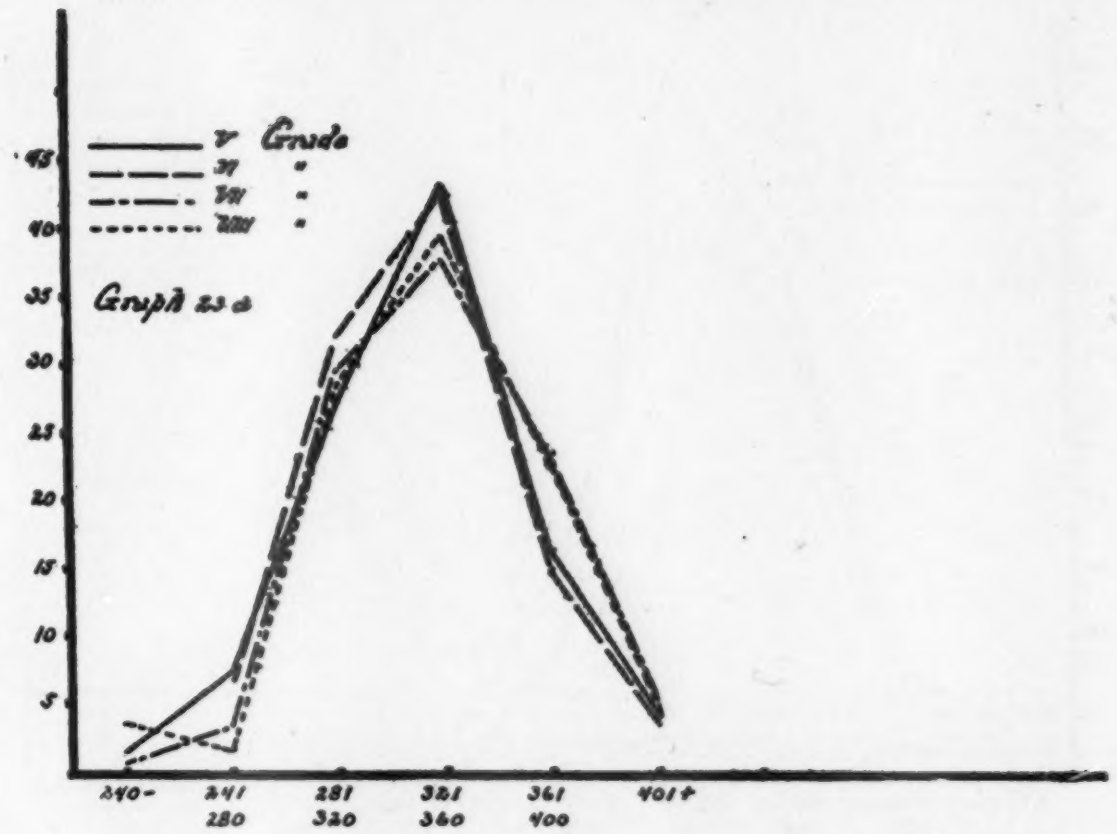
NUMBER OF TAPS IN ONE MINUTE.
14 YEARS. RIGHT HAND. BOYS.



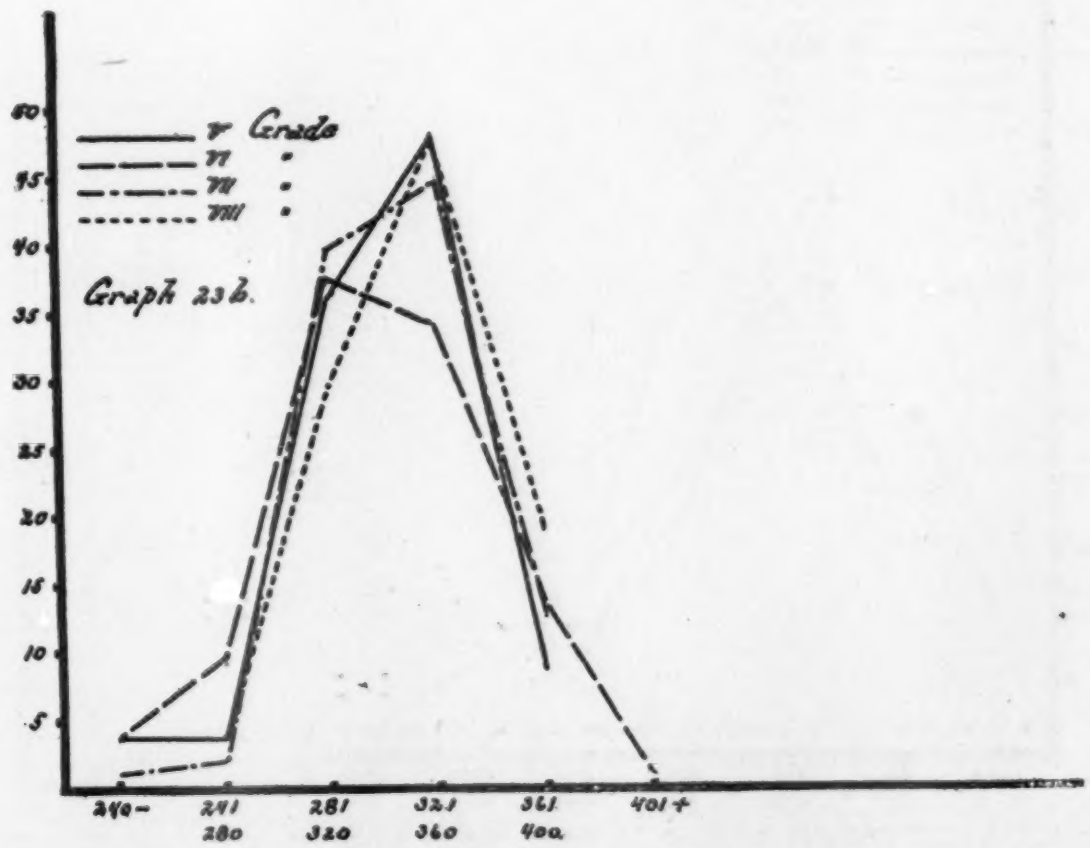
NUMBER OF TAPS IN ONE MINUTE.
14 YEARS. RIGHT HAND. GIRLS.



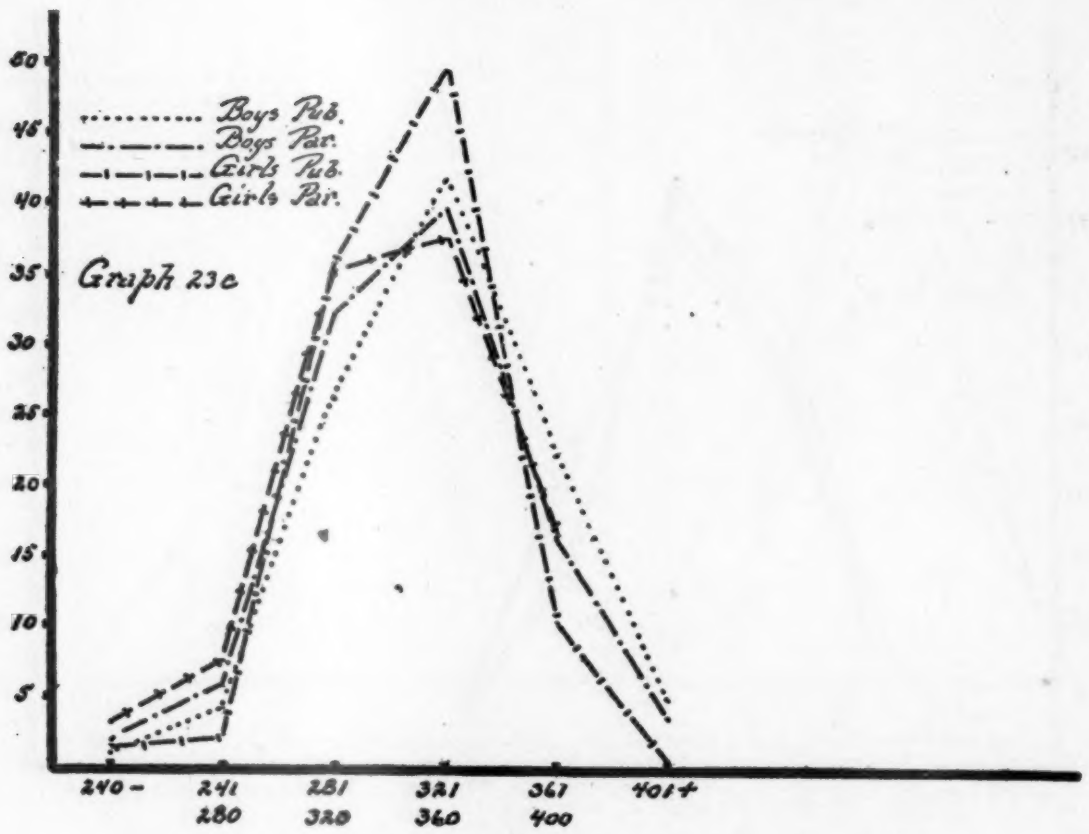
NUMBER OF TAPS IN ONE MINUTE. 14 YEARS. RIGHT HAND.



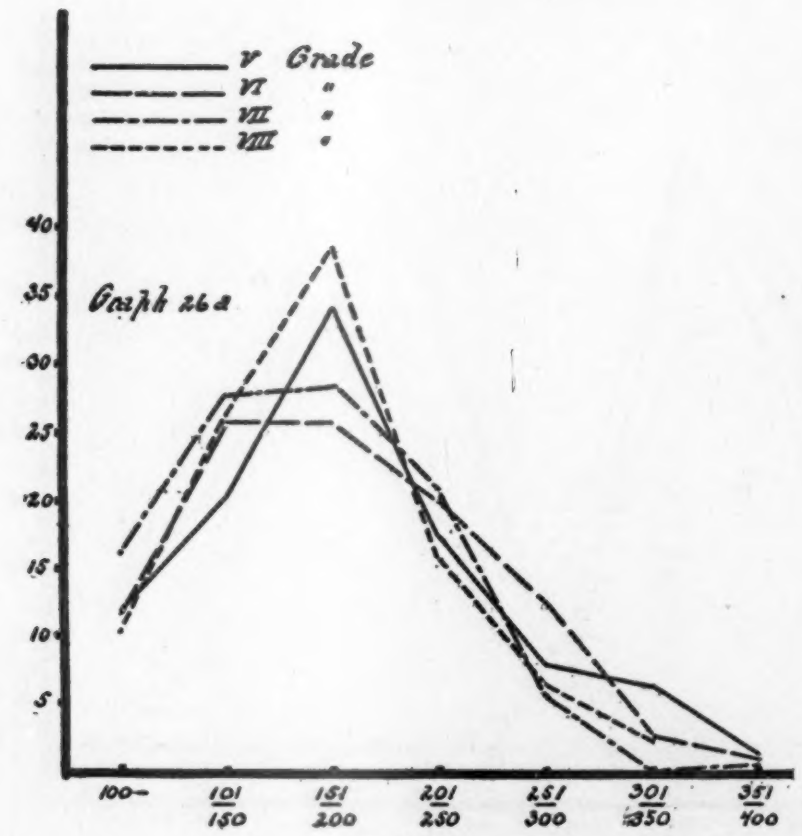
NUMBER OF TAPS IN ONE MINUTE. 15 YEARS. RIGHT HAND. BOYS.



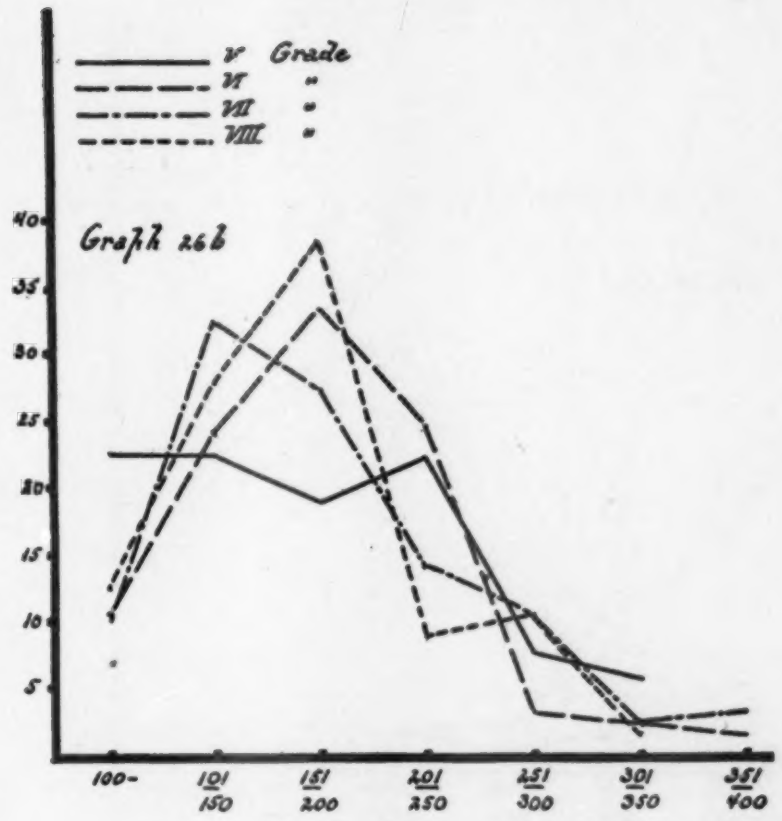
NUMBER OF TAPS IN ONE MINUTE. 15 YEARS. RIGHT HAND. GIRLS.



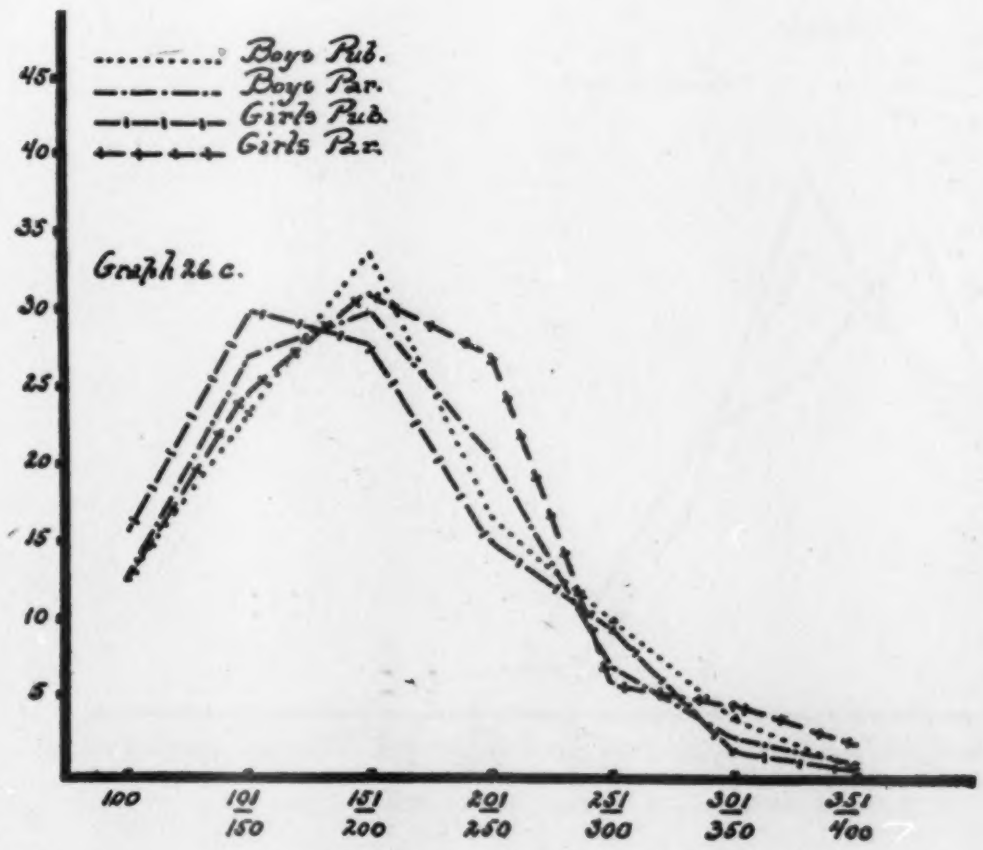
NUMBER OF TAPS IN ONE MINUTE. 15 YEARS. RIGHT HAND.



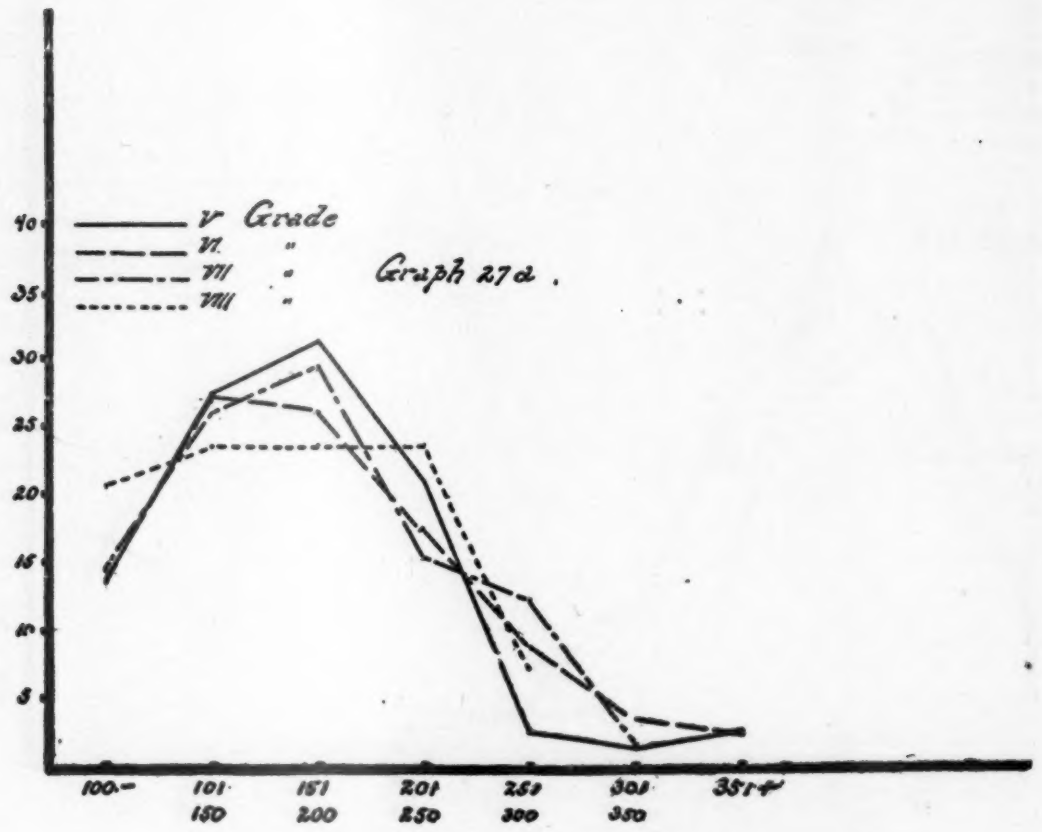
INDEX OF FATIGUE. 14 YEARS. RIGHT HAND. BOYS.



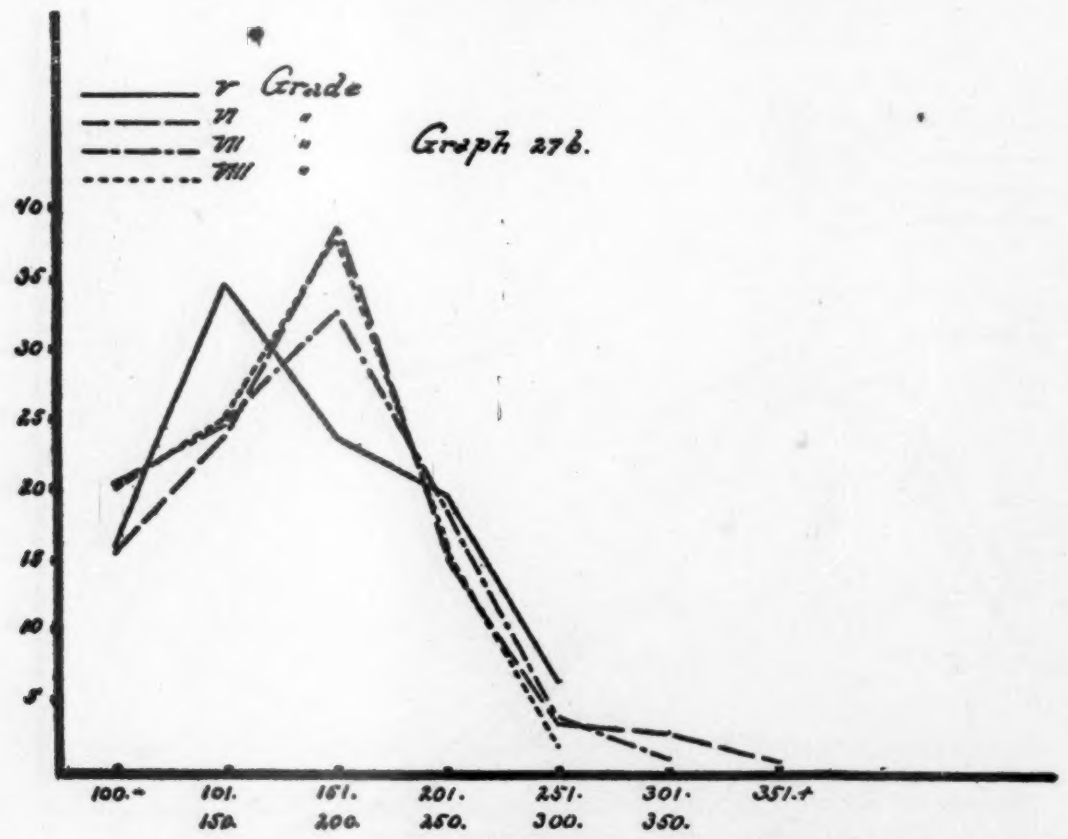
INDEX OF FATIGUE. 14 YEARS. RIGHT HAND. GIRLS.



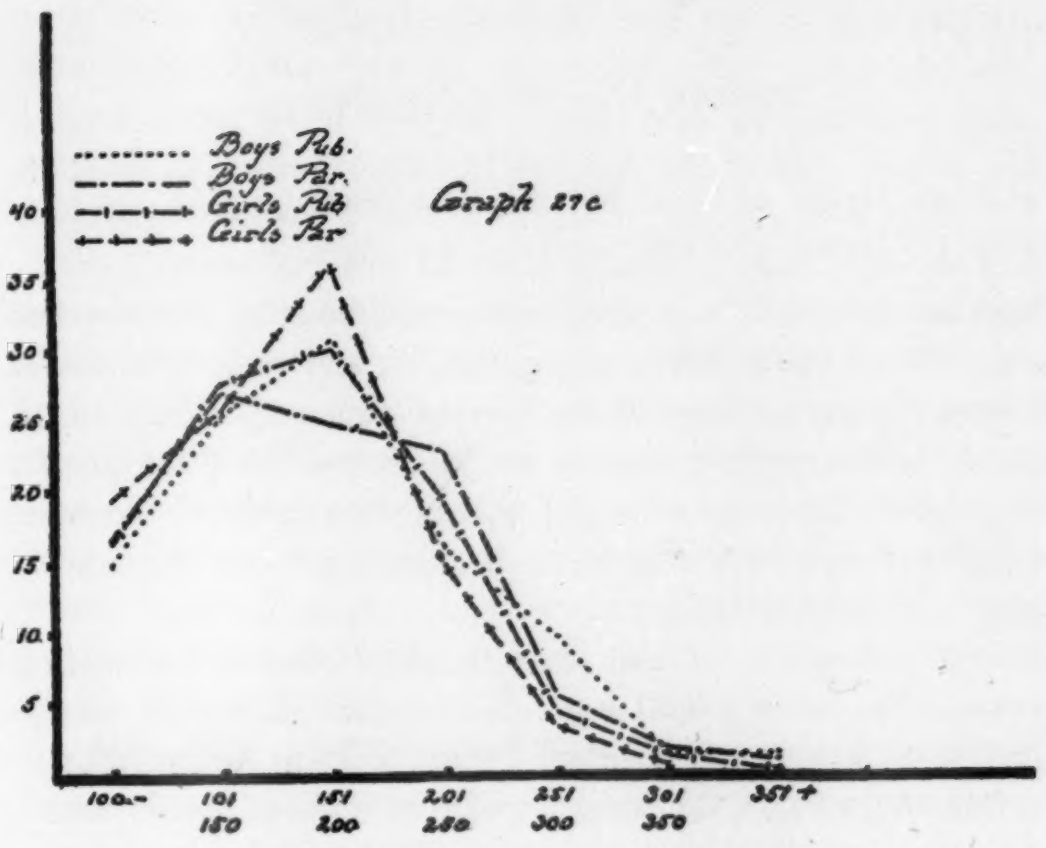
INDEX OF FATIGUE. 14 YEARS. RIGHT HAND.



INDEX OF FATIGUE. 15 YEARS. RIGHT HAND. BOYS.



INDEX OF FATIGUE. 15 YEARS. RIGHT HAND. GIRLS.



INDEX OF FATIGUE. 15 YEARS. RIGHT HAND.

Section IX—Card Sorting

Table 30, Index of Card Sorting—14 years.
Table 31, Index of Card Sorting—15 years.

Materials—A black box, with four compartments, each marked with a circle of color—blue, green, yellow, and red. The colors used were the pure colors of the Hering papers. A pack of 48 cards, each one marked with a circle of one of these colors, twelve of each kind—so arranged that no two cards of the same color followed one another, and so that there were no rhythms of sequence. A stop-watch.

Criticism—Because of the much greater ease in calculating accuracy, fifty cards would have been better than forty-eight. The entire apparatus was ordered from Stoelting & Co. Forty-eight was the size of the largest pack of colored cards which could be made up from the sets which came with it.

Method of administering the test—Children who were so short that they could not reach the box comfortably when it was placed on a table, were allowed to stand on a platform of the required height (see steadiness test). The child was placed directly in front of the box, and close to it so that no reaching was involved in the process of sorting. The instructions were given as follows:

"You see this black box with the four parts—each one marked with a color. Tell me what color this is, and this one. Yes. Now each of these cards is marked with a circle of one of those colors (showing him several). What I want you to do is to drop each card into the part of the box marked with its own color, and see how fast you can do it. You are right-handed, are you not? Then take the pack of cards in your left hand, turned face down, and hold them that way until I tell you to begin. If you should make a mistake and drop a card into the wrong division, don't stop to try to change or correct it, because that would take too much time. Just go right on and see how fast you can get it done. When I say 'now,' turn the whole

pack over, and begin dropping them in just as fast as you can." The experimenter started the watch after the pack had been turned over, when the child took hold of the first card, and stopped it as he dropped in the last one. The time in seconds, and the number and nature of the errors were recorded.

Criticism—The test is undoubtedly a good one as a simple measure of an eye-hand coördination. The only doubt to be thrown upon it is that it may be modified by defects of color vision. Extreme cases of color blindness are easily detected by the number and nature of the errors. The question is whether lesser defects of color vision might cause a lengthening of the time, without becoming evident in the kind of errors. Since the colors were all as pure and as saturated as paper can be made, it is improbable that a lengthened time of perception is an appreciable factor in the result.

Method of dealing with results—The time was recorded in seconds, and the accuracy in per cents. These two measurements were then combined into an index by dividing the time by the accuracy, giving the estimated time for a perfect performance. Since there were rarely more than two errors, the index does not differ widely from the time. The tables and curves are based upon the index.

Criticism—The index, as an estimated time for a perfect performance, has in it, in this case, a source of error. The assumption is, of course, that a child who makes errors could have done the sorting without them by taking more time. But since every child is conscious of his errors, and invariably loses time by becoming disturbed over them, the very making of the error increases the time. The index, therefore, seems to place a double penalty on errors. Regarded as an arbitrary way of penalizing records which contain errors, the index has a meaning.

RESULTS

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	44.7	41.7	41.1	36.8
50 perc.	50.7	46.4	45.0	40.8
75 perc.	56.9	51.9	49.9	45.2
Q	6.1	5.1	4.4	4.2
Limits—				
Lower	29.3	28.4	31.4	28.5
Upper	80.6	78.5	83.5	83.3

Index of card sorting in seconds, percentiles and limits

Correlation with school grade.

Graph 30a—Boys, 14 years.

Graph 30b—Girls, 14 years.

Graph 31a—Boys, 15 years.

Graph 31b—Girls, 15 years.

There is a very marked positive correlation with school grade, both at fourteen and at fifteen years, and it is even more decided in the graphs for boys than in those for girls.

Comparisons of Sex and School.

Graph 30c—14 years.

Graph 31c.—15 years.

Sex—Both the percentiles and the graphs show a marked superiority of the girls in this test. As a group, they are from five to six seconds faster than the boys,—a difference which is even more marked at fifteen years than at fourteen.

School—The public school children, both boys and girls, are decidedly superior to the parochial school children at both ages.

Age—The fifteen-year-old children of both sexes are faster than the fourteen-year group, by from four to five seconds. The girls gain a trifle more than the boys.

TABLE 30

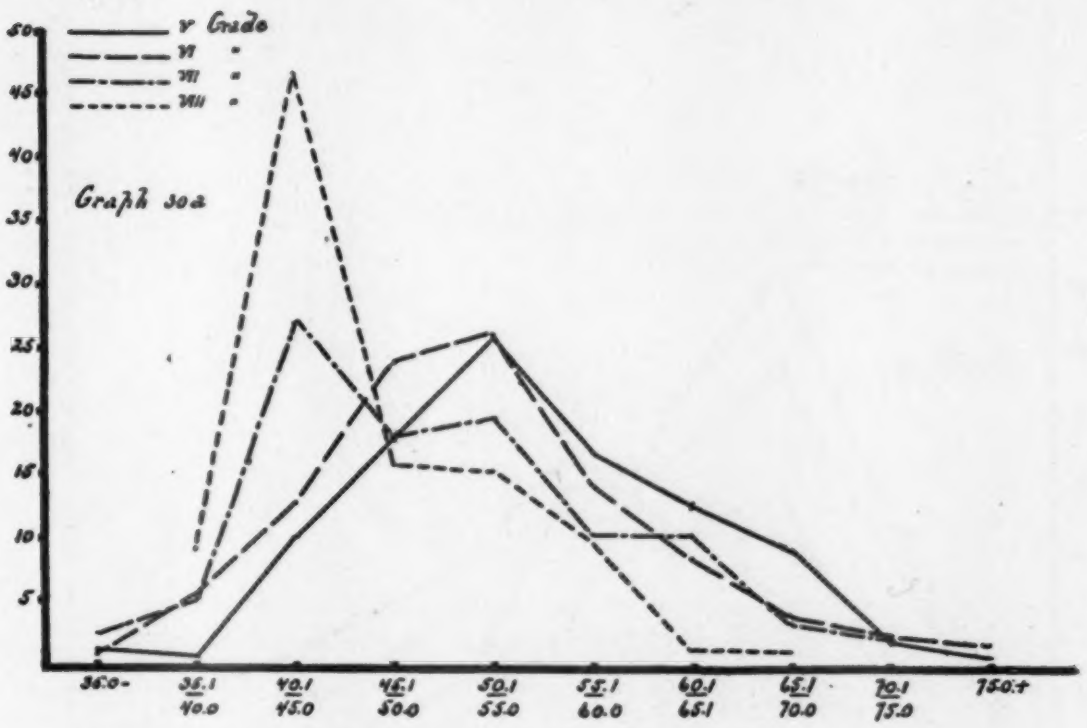
Index of Card Sorting. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Seconds	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
PUBLIC SCHOOL	35.0—	2	2.4	0	0.0	1	2.3	0		0.0		0	0.0	0		1	2.5	3	1	14.8	
	35.1 - 40.0	1	1.2	6	9.4	2	4.6	3		13.0		4	9.5	9	15.8	6	15.0	7	1	29.6	
	40.1 - 45.0	10	11.9	6	9.4	15	34.9	12	2	60.9		12	28.6	19	33.3	16	40.0	10	1	40.7	
	45.1 - 50.0	18	21.4	20	31.2	8	18.6	3		13.0		15	35.7	18	31.6	11	27.5	3		11.1	
	50.1 - 55.0	24	28.6	17	26.6	7	16.3	1		4.3		7	16.7	5	8.8	6	15.0	0		0.0	
	55.1 - 60.0	14	16.7	6	9.4	4	9.3	2		8.7		2	4.7	3	5.3	0	0.0	1		3.7	
	60.1 - 65.0	10	11.9	3	4.7	4	9.3	0		0.0		1	2.4	1	1.7	0	0.0	0		0.0	
	65.1 - 70.0	1	1.2	4	6.2	1	2.3	0		0.0		1	2.4	0	0.0	0	0.0	0		0.0	
	70.1 - 75.0	3	3.6	2	3.1	1	2.3	0		0.0		0	0.0	1	1.7	0	0.0	0		0.0	
	75.1+	1	1.2	0	0.0	0	0.0	0		0.0		0	0.0	1	1.7	0	0.0	0		0.0	
	Total	84		64		43		21	2			42		57		40		24			
	Omitted	2		4		0		1	0			1		2		3		0			
PAROCHIAL SCHOOL	35.0—	0	0.0	1	1.8	2	3.2	0		0.0		1	4.0	0	0.0	2	3.7	1		3.0	
	35.1 - 40.0	0	0.0	1	1.8	4	6.4	2		5.4		4	16.0	1	2.4	8	14.8	5	3	24.2	
	40.1 - 45.0	3	8.6	9	16.4	12	19.3	9	3	32.4		6	24.0	14	34.1	15	27.8	9		27.3	
	45.1 - 50.0	5	14.3	9	16.4	11	17.7	7		18.9		3	12.0	11	26.8	10	18.5	11		33.3	
	50.1 - 55.0	8	22.8	14	25.4	14	22.5	10		27.0		6	24.0	7	17.1	14	25.9	4		12.1	
	55.1 - 60.0	6	17.1	10	18.2	7	11.3	4		10.8		2	8.0	5	12.2	2	3.7	0		0.0	
	60.1 - 65.0	5	14.3	7	12.7	7	11.3	1		2.7		1	4.0	1	2.4	1	1.8	0		0.0	
	65.1 - 70.0	6	17.1	1	1.8	3	4.8	1		2.7		0	0.0	2	4.9	2	3.7	0		0.0	
	70.1 - 75.0	2	5.7	1	1.8	2	3.2	0		0.0		1	4.0	0	0.0	0	0.0	0		0.0	
	75.1+	0	0.0	2	3.6	0	0.0	0		0.0		1	4.0	0	0.0	0	0.0	0		0.0	
	Total	35		55		62		34	3			25		41		54		30	3		
	Omitted	3		4		3		3	0			1		2		1		1	0		

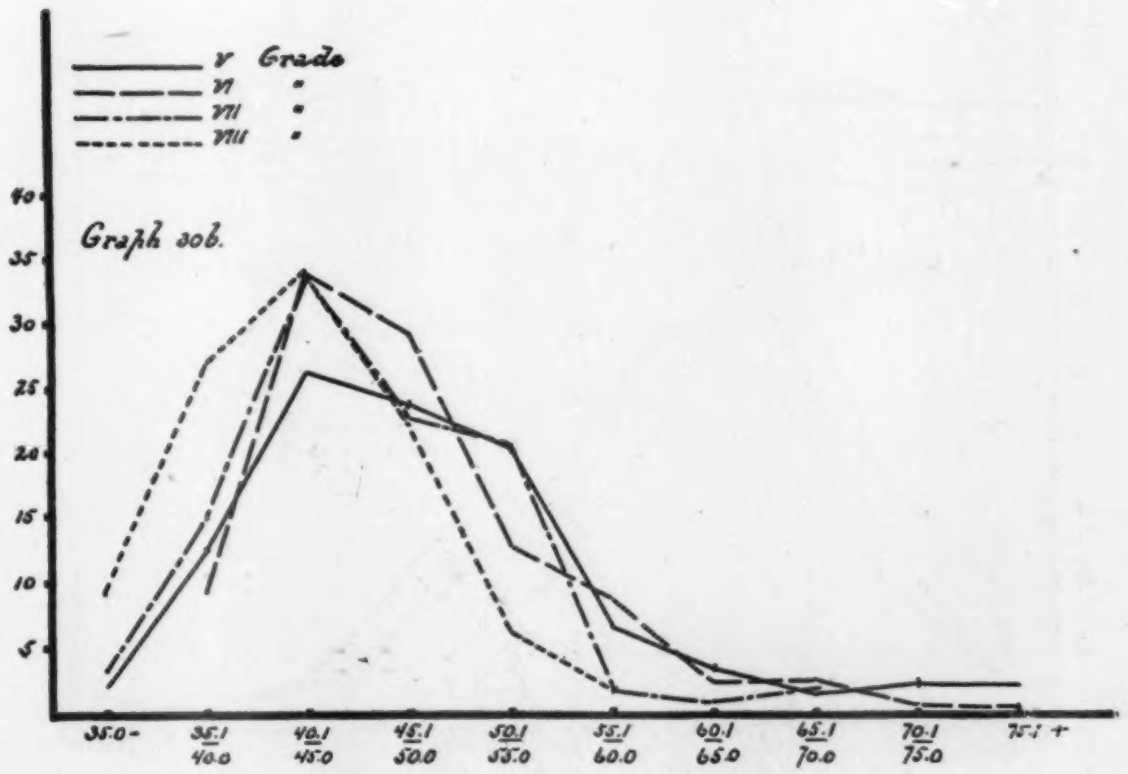
TABLE 31

Index of Card Sorting. 15 years

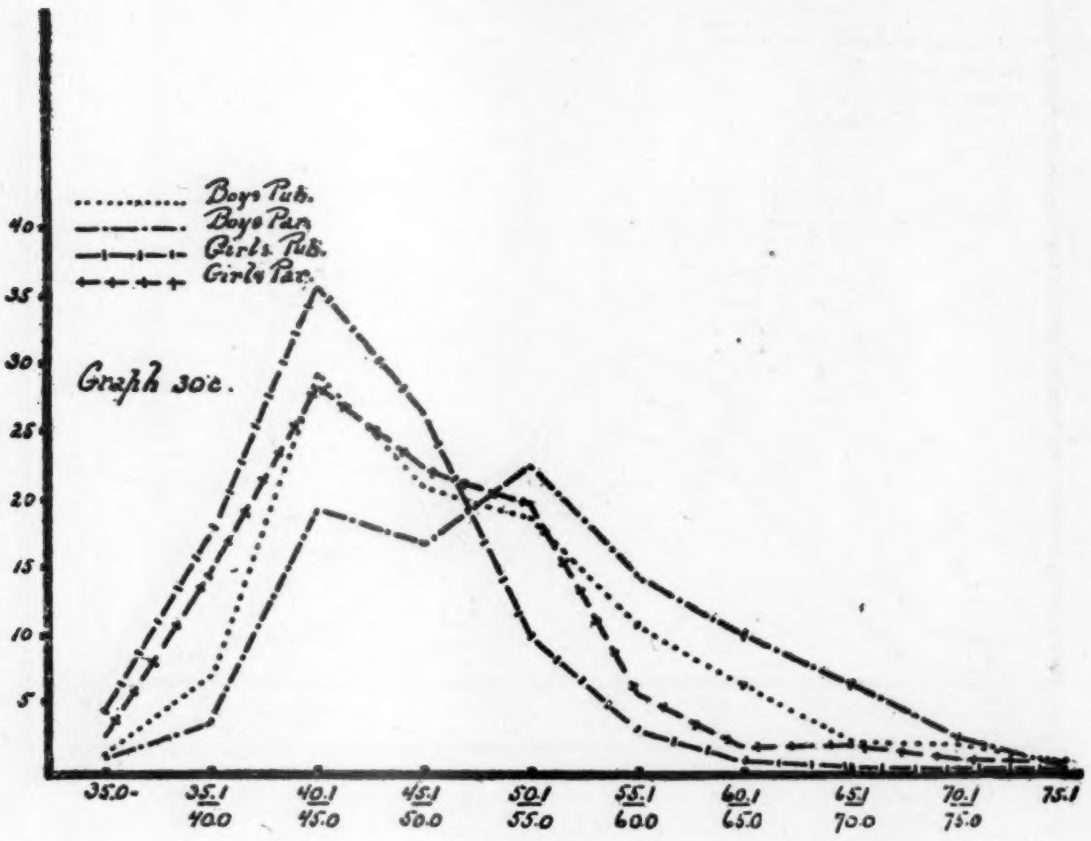
School	Grade	Boys										Boys									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
Public School	Seconds	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
	35.0—	3	3.9	3	5.0	2	5.3	2	2	16.7		2	5.5	4	7.8	6	16.7	9	1	47.6	
	35.1 - 40.0	8	10.4	5	8.3	6	15.8	3		12.5		12	33.3	20	39.2	9	25.0	8		38.1	
	40.1 - 45.0	20	26.0	12	20.0	10	26.3	13		54.2		12	33.3	12	23.5	19	52.8	2		9.5	
	45.1 - 50.0	15	19.5	21	35.0	11	28.9	2		8.3		7	19.4	7	13.7	2	5.5	1		4.8	
	50.1 - 55.0	16	21.0	8	13.3	4	10.5	2		8.3		2	5.5	7	13.7						
	55.1 - 60.0	12	15.5	4	6.7	5	13.2					1	2.8	0							
	60.1 - 65.0	3	3.9	4	6.7									1	2.0						
	65.1 - 70.0	0		1	1.7																
	70.0+	0		2	3.3																
	Total	77		60		38		22	2			36		51		36		20	1		
	Omitted	3		2		5								2							
Parochial School	35.0—	1	3.2	1	2.0	1	1.6	1		3.1		1	4.2	1	2.9	8	15.7	5	1	24.	
	35.1 - 40.0	3	9.7	6	12.2	6	9.8	7		21.9		6	25.0	9	25.7	16	31.4	7	2	36.	
	40.1 - 45.0	4	12.9	14	28.5	20	32.8	6		18.7		5	20.8	13	37.1	12	23.5	7		28.	
	45.1 - 50.0	8	25.8	11	22.4	17	27.9	11		34.4		7	29.2	3	8.6	7	13.7	3		12.	
	50.1 - 55.0	8	25.8	10	20.4	10	16.4	4		12.5		3	12.5	7	20.	1	2.0				
	55.1 - 60.0	4	12.9	6	12.2	6	9.8	3		9.4		1	4.2	0		7	13.7				
	60.1 - 65.0	2	6.4	0		1	1.6	0				0		1	2.9						
	65.1 - 70.0	0		1	2.0							0		1	2.9						
	70.0+	1	3.2									1	4.2								
	Total	31		49		61		32				24		35		51		22	3		
	Omitted	4		4										2							



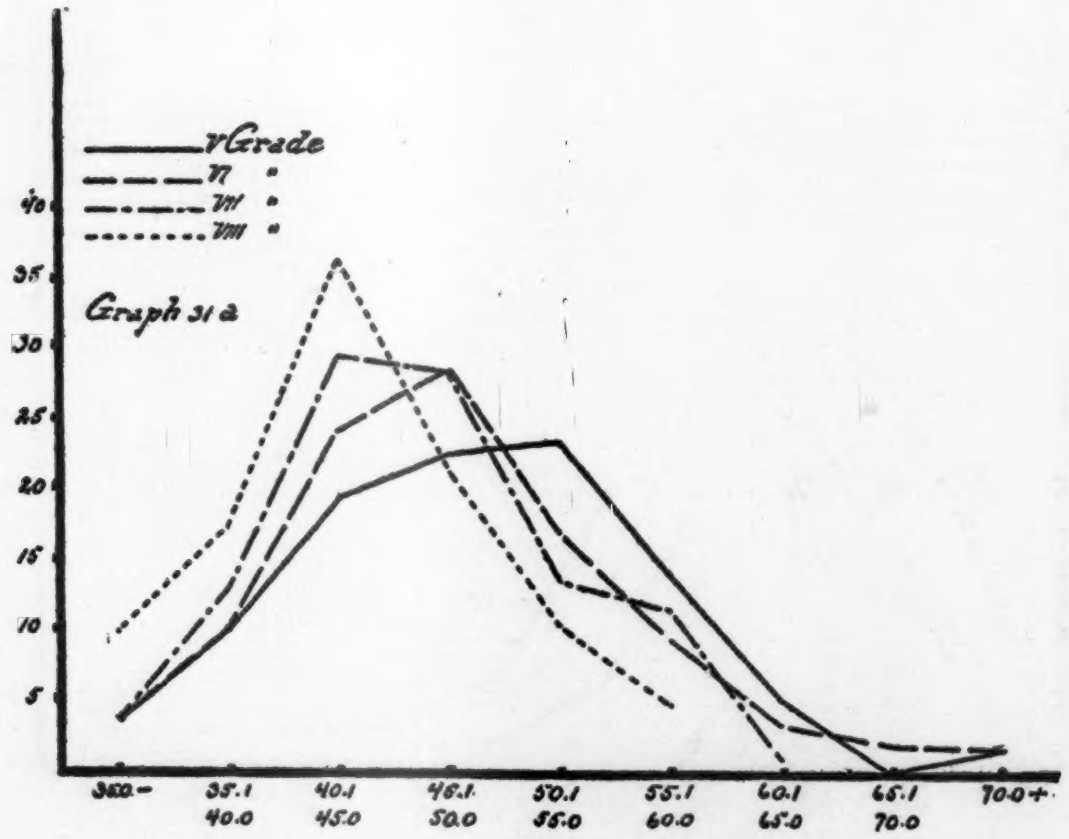
INDEX OF CARD SORTING. 14 YEARS. BOYS.



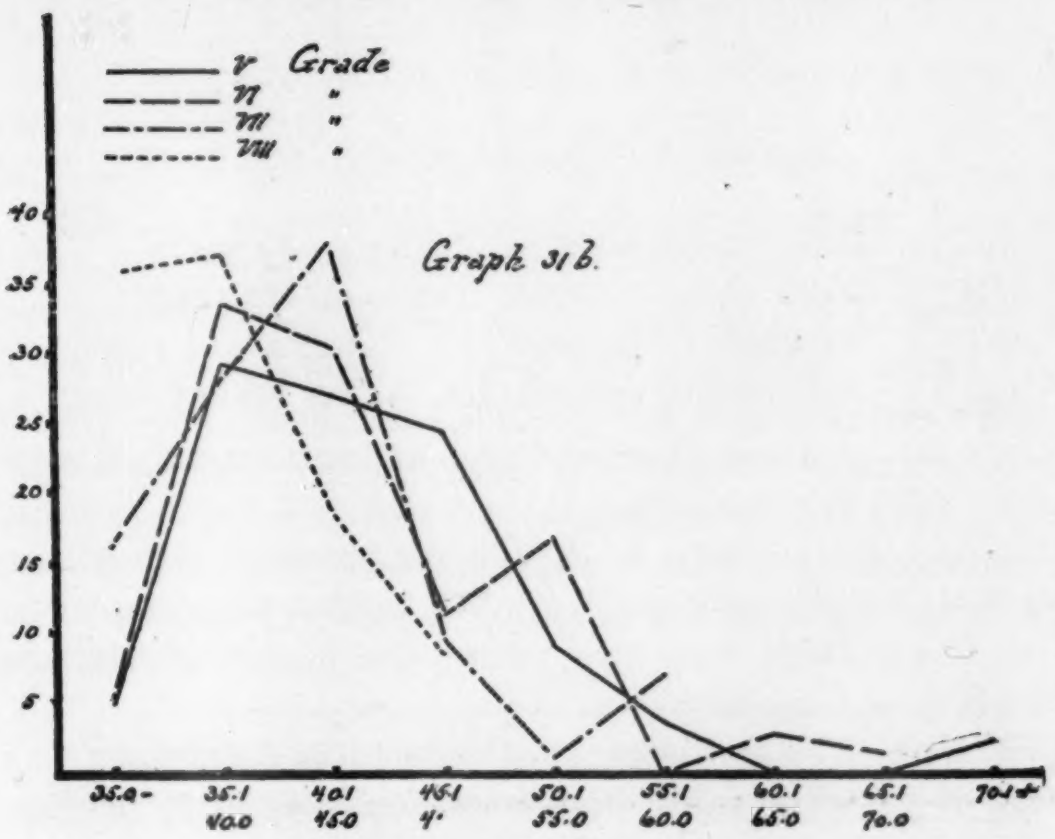
INDEX OF CARD SORTING. 14 YEARS. GIRLS.



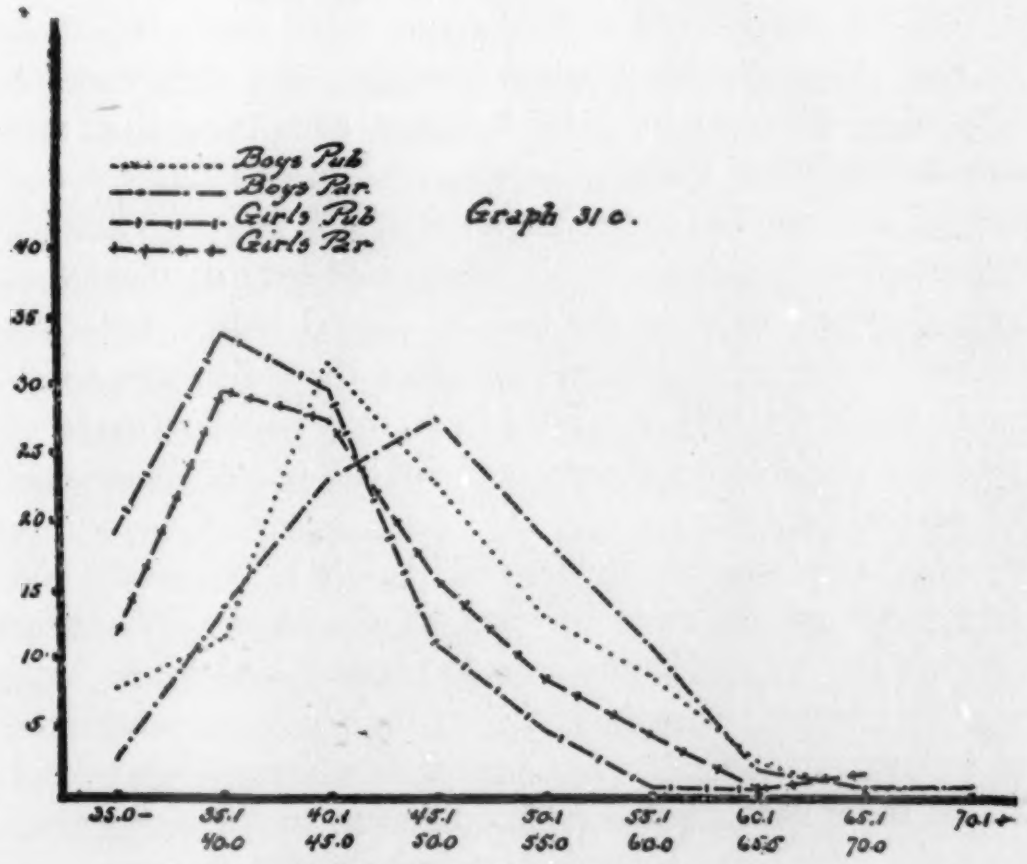
INDEX OF CARD SORTING. 14 YEARS.



INDEX OF CARD SORTING. 15 YEARS. BOYS.



INDEX OF CARD SORTING. 15 YEARS. GIRLS.



INDEX OF CARD SORTING. 15 YEARS.

Section X—Cancellation Test

Table 32. Index of cancellation. Letter a—14 years.
Table 33. Index of cancellation. Letter m—15 years.
Table 34. Accuracy of cancellation. Letter a—14 years.
Table 35. Accuracy of cancellation. Letter m—15 years.

Materials—A standard printed page of small letters. A stop-watch. (See Whipple's Manual, Test 26.)

The page contains fifty of each of the letters of the alphabet irregularly distributed through it. We verified the count for a, m, w, r, s. There were two forms, one beginning with the letters h, p, and one with c, z.

Criticisms—The first printing of these pages contained 51 a's instead of 50, which made the computation of accuracy difficult. Furthermore the use of small letters for this purpose seems questionable. Since capital letters are uniform at least with respect to height, a standard page of capitals, similarly made up, seems wiser. All the letters used in this series, were letters which do not extend either above or below the line, but differences in difficulty were still evident. For instance, m is an easier letter to mark than a. The same letter was used in this series for all the tests of one age, but the comparison of one age with another is rendered difficult because of the change of letters. Doubtless similar differences exist in the case of capital letters, but their greater uniformity of height would reduce the differences somewhat. It would be very desirable to have a standard page of capitals adopted, and the differences in difficulty carefully worked out for several letters.

Method of administering the test—The page to be marked was laid face down on the table in front of the child. The other page, with a few sample letters already marked, was in the hand of the experimenter, who showed it to the child and instructed him as follows:

"On the other side of this page (pointing to the one turned down on the table) are some letters just printed in rows, like

this. What I want you to do, is to draw a single line with your pencil through every 'a' on this page, just the way it is done here, and see how fast you can do it. If you should make a mistake, and draw a line through the wrong letter, don't stop to erase it, or try to correct it, because that would take too long—just go ahead. Of course I want you to be sure to mark *every* 'a' on the page, and do it just as fast as possible. When I turn the page over, begin, and I will take your time with this watch."

The watch was started after the page was turned over, just as the child began to look for a's, and was stopped as he finished the last line. The most important point about the instructions is to see that the factors of speed and accuracy are equally emphasized.

In the fifteen-year series, m's were marked.

Method of dealing with results—The time of the test was recorded in seconds, and the accuracy in per cents. When no wrong letters were crossed, the accuracy was a simple matter of deducting two per cent for every omission—except for the page containing fifty-one a's, for which a table of per cents was figured out.

When wrong letters were crossed, the accuracy was figured according to the formula, expressed concretely for this test,

$$\text{accuracy} = \frac{\text{letters correctly marked}}{50 + \text{letters wrongly marked}}$$

(See Whipple's Manual, page 260.) An index which consisted of time divided by accuracy, representing an estimated time for a perfect performance, was calculated in each case.

Criticisms—The method of estimating accuracy when incorrect letters were crossed did not seem fair for the most frequent type of error. There were very few cases in which a completely wrong letter was crossed. The usual error was to cross the letter next to the "a" instead of the "a" itself, due to poor motor coördination rather than to defective perception, and although we counted correct any "a" that was touched by the mark, even though the line went more definitely through another letter, the formula inflicts a double penalty for such an error, since it counts off both for the "a" omitted, and for the letter wrongly crossed.

In papers in which many errors of this type occur, the injustice is glaring, but in most instances there were not more than one or two such errors. Some modification of the formula for this special case ought to be agreed upon.

RESULTS

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	186.6	155.7	164.3	129.9
50 perc.	220.2	182.6	195.2	150.8
75 perc.	272.7	215.2	236.6	177.2
Q	43.0	29.8	46.1	23.7
Limits—				
Lower	113.8	105.1	111.5	84.1
Upper	726.9	354.4	521.5	402.4

Index of cancellation in seconds, Letter a, 14 years. Letter m, 15 years
Percentiles and limits

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	71.1	88.6	70.7	90.2
50 perc.	83.3	94.8	81.6	96.3
75 perc.	91.1	97.9	90.3	98.4
Q	10.0	4.7	9.8	4.1
Limits—				
Lower	19.0	50.0	30.8	52.0
Upper	100	100	100	100

Accuracy of cancellation in percents—Letter a—14 years. Letter m—15 years.
Percentiles and limits

Correlation with school grade.

Graph 32a—Boys—Letter a—14 years, Index,
Graph 32b—Girls—Letter a—14 years, Index,
Graph 33a—Boys—Letter m—15 years, Index,
Graph 33b—Girls—Letter m—15 years, Index.

Graph 34a—Boys—Letter a—14 years—Accuracy,
Graph 34b—Girls—Letter a—14 years—Accuracy,
Graph 35a—Boys—Letter m—15 years—Accuracy,
Graph 35 b—Girls—Letter m—15 years—Accuracy.

The graphs for the index, for both sexes and both ages, show a positive correlation with school grade. It is more marked and more consistent in the case of the girls than in that of the boys.

The graphs for accuracy also show a positive correlation with school grade. It is more marked among the boys than among the girls—particularly in the fourteen-year graphs.

Comparisons of sex and school.

Graph 32c—Letter a—14 years—index,
Graph 33c—Letter m—15 years—index,
Graph 34c— Letter a—14 years—accuracy,
Graph 35c—Letter m—15 years—accuracy.

Sex—Both the percentiles and the graphs for the fourteen- and the fifteen-year group show a decided superiority of the girls over the boys in the index of the cancellation test. The difference between the sexes is greater at fifteen than at fourteen. At fourteen, the girls as a group are about 20 seconds faster than the boys, and at fifteen about 30 seconds faster.

The question as to whether the speriority of the girls consisted chiefly in speed or in accuracy can be decided by inspecting the percentiles and graphs for accuracy alone. At fourteen years, the percentiles and graphs for accuracy are very slightly better for the boys than for the girls. At fourteen, then, the advantage of the girls lay entirely in their greater speed. In this they excelled enough to more than counterbalance a slightly lower degree of accuracy. At fifteen years, the girls have the advantage in both speed and accuracy, though their superiority in speed is the more striking.

School—The differences between the graphs for the two types of school are not large or consistent enough to be of any significance.

Age—It is impossible in this case to make a satisfactory comparison of the two ages, because of the change in the letter to

be cancelled. There is no question but that "m" is an easier letter to cancel than "a," and without further measures as to just how much easier it is than a, one cannot say how much of the improvement from fourteen to fifteen is due to the easier letter, and how much to the added year of age. One can, however, state that the girls gained more in both speed and accuracy in the second test than the boys.

TABLE 32

Index of Cancellation. Letter a. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Seconds	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	120.0—	0	0.	0		0		0	0			0		0		0		3	0		
	120.1 - 140.0	2		1		1		1				1		1		4		1			
	140.1 - 160.0	1	3.6	5	8.9	4	11.6	1		8.3		2	7.0	3	6.9	8	29.3	6		38.5	
	160.1 - 180.0	4		8		5		2				8		11		7		3			
	180.1 - 200.0	13	20.3	9	25.4	8	30.2	3	1	25.0		10	41.9	11	37.9	6	31.7	5	1	34.6	
	200.1 - 220.0	11		10		5		5	1			6		3		2		2	1		
	220.1 - 240.0	12	27.4	6	23.9	6	25.6	0		25.0		6	27.9	9	20.7	6	19.5	2		19.2	
	240.1 - 260.0	5		9		3		2				1		5		2		2			
	260.1 - 280.0	12	20.2	2	16.4	2	11.6	1		12.5		4	11.6	3	13.8	1	7.3			7.7	
	280.1 - 300.0	5		4		1		0				0		2		2					
	300.1 - 320.0	4	10.7	3	10.4	3	9.3	2		8.3		2	4.6	3	8.6	1	7.3			0.0	
	320.1 - 340.0	0		3		1		1				1		2		1					
	340.1 - 360.0	4	4.8	0	4.5	1	4.6	4		20.8		0	2.3	2	6.9	1	4.9			0.0	
	360.1 - 380.0	3		1		0		0				0		0		0					
	380.1 - 400.0	3	7.2	2	4.5	0	0.0	0		0.0		1	2.3	0	0.0	0	0.0			0.0	
	400.1 - 420.0	1		1		1		0				0		1		0					
	420.1+	4	6.0	3	6.0	2	7.0	0		0.0		1	2.3	2	5.2	0	0.0			0.0	
	Total	84		67		43		22	2			43		58		41		24	2		
	Omitted	2		1		0		0	0			0		1		2		0	0		
Parochial School	120.1—	0		0		1		1				0		0		1		1	0		
	120.1 - 140.0	0		0		1		1				1		4		4		3			
	140.1 - 160.0	3	8.1	1	1.7	10	18.5	1	1	10.2		4	20.0	2	14.3	11	29.1	7	2	40.6	
	160.1 - 180.0	4		8		8		9				3		8		11		2	1		
	180.1 - 200.0	3	18.9	8	27.6	9	26.1	6	1	41.0		2	20.0	5	30.9	6	30.9	4		21.9	
	200.1 - 220.0	4		11		12		4				4		6		9		4			
	220.1 - 240.0	5	24.3	8	32.7	7	29.2	3		17.9		5	36.0	5	26.2	4	23.6	1		15.6	
	240.1 - 260.0	1		8		6		3	1			1		0		3		3			
	260.1 - 280.0	6	18.9	3	19.0	3	13.8	2		15.4		2	12.0	1	2.4	1	7.3	0		9.4	
	280.1 - 300.0	2		3		3		1				2		2		2		0			
	300.1 320.0	3	13.5	3	10.3	2	7.7	1		5.1		1	12.0	4	14.3	1	5.4	2		6.2	
	320.1 - 340.0	1		3		0		1				0		1		1		1			
	340.1 - 360.0	1	5.4	0	5.2	1	1.5	2		7.7		0	0.0	1	4.8	1	3.6	0		3.1	
	360.1 - 380.0	2		0		1		0				0		0		0		1			
	380.1 - 400.0	1	8.1	2	3.4	0	1.5	0		0.0		0	0.0	1	2.4	0	0.0	0		3.1	
	400.1 - 420.0	0		0		0		0				0		0		0		0			
	420.1+	1	2.7	0	0.0	1	1.5	1		2.6		0	0.0	2	4.8	0	0.0	0		0.0	
	Total	37		58		65		36	3			25		42		55		29	3		
	Omitted	1		1		0		1	0			1		1		0		2	0		

TABLE 33
Index of Cancellation. Letter m. 15 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Seconds	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100.1 - 120.0	1	1.3	1	1.7	1	2.3	0				1	2.8	6	11.8	4	11.8	4		19.0	
	120.1 - 140.0	6		5		5		1				10		7		10		7	1		
	140.1 - 160.0	13	24.0	11	26.6	6	25.6	2	1	16.7		12	61.1	13	39.2	4	41.2	4		57.1	
	160.1 - 180.0	9		13		9		6	1			4		12		9		2			
	180.1 - 200.0	16	31.6	5	30.0	9	41.9	7		58.3		3	19.4	9	41.2	4	38.2	2		19.0	
	200.1 - 220.0	12		11		8		4				3		2		3		0			
	220.1 - 240.0	10	27.9	9	33.3	3	25.6	0		16.7		2	13.9	1	5.9		8.8	0		0.0	
	240.1 - 260.0	8		4		1		1				0		1				1			
	260.1 - 280.0	1	11.4	0	6.7	0	2.3	0		4.2		1	2.8		2.0					4.8	
	280.1 - 300.0	2		1		1		1													
	300.1 - 320.0	0	2.5		1.7		2.3			4.2											
	320.1 - 340.0	0																			
	340.0+	1	1.3																		
	Total	79		60		43		22	2			36		51		34		20	1		
	Omitted	1		2										2		2					
Parochial School	100.1 - 120.0	0		1	1.9	3	4.8	0				2	8.7	5	13.9	8	16.3	6		21.4	
	120.1 - 140.0	3		5		9		4				3		9		13		7	1		
	140.1 - 160.0	5	23.5	12	32.7	12	33.9	3		23.3		6	39.1	6	41.6	13	53.1	6	1	53.6	
	160.1 - 180.0	7		7		13		9				5		4		7		2	1		
	180.1 - 200.0	3	29.4	6	25.0	11	38.7	5		46.7		3	34.8	5	25.0	5	24.5	0		10.7	
	200.1 - 220.0	5		7		4		4				1		1		1		2			
	220.1 - 240.0	5	29.4	10	32.7	6	16.1	4		26.7		1	8.7	1	5.6	1	4.1	1		10.7	
	240.1 - 260.0	2		1		2		0				2		2		0		0			
	260.1 - 280.0	0	5.9	2	5.8	1	4.8	1		3.3			8.7	0	5.6	1	2.0	0		0.0	
	280.1 - 300.0	0		1		1								0				1			
	300.1 - 320.0	2	5.9		1.9		1.6							0						3.6	
	320.1 - 340.0	0												0							
	340.0+	2	5.9											3	8.3						
	Total	34		52		62		30				23		36		49		25	3		
	Omitted	1		1				3				1				2		1			

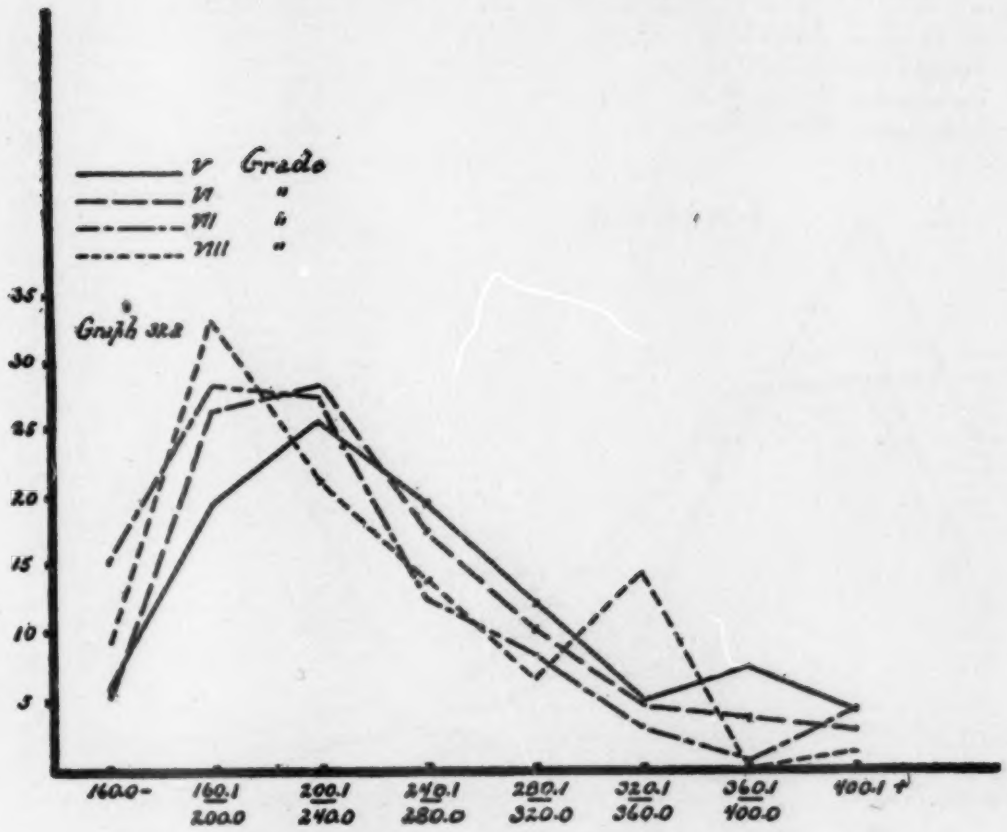
TABLE 34

Accuracy of Cancellation. Letter a. 14 years

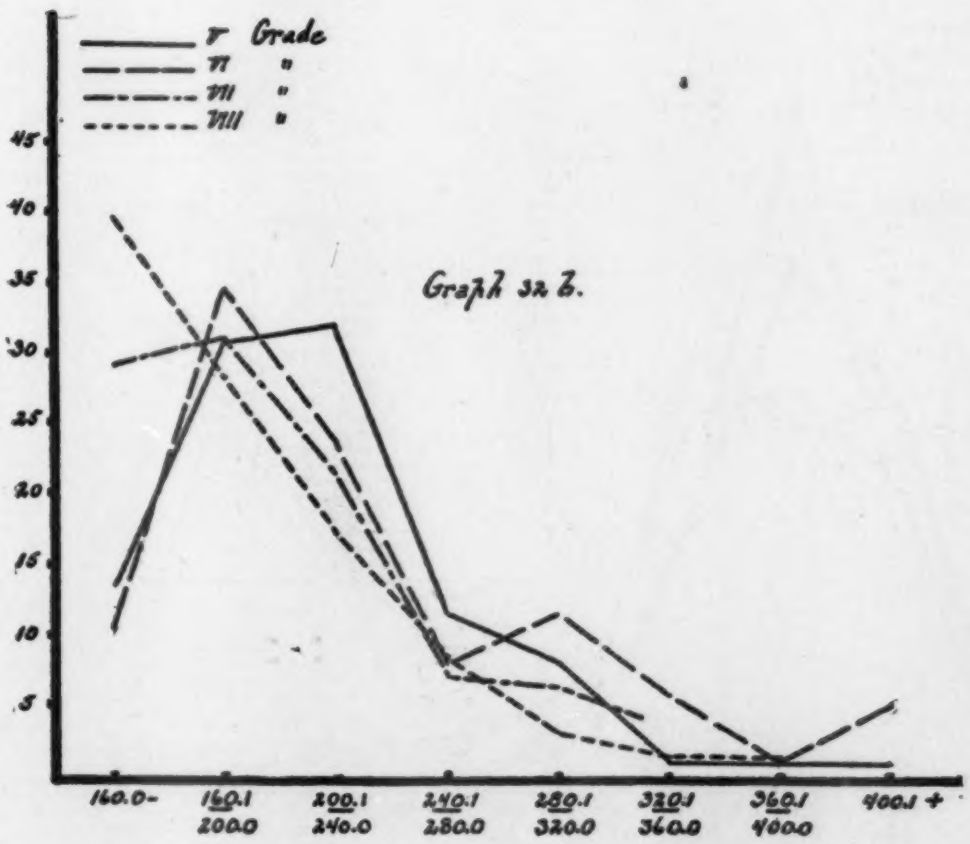
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100 - 95.6	9		10		16		6	1			2		7		6		4			
	95.5 - 90.6	1	11.8	7	25.3	1	39.5	6	1	58.4		2	9.2	9	27.2	5	26.2	5		34.6	
	90.5 - 85.6	16		21		7		2				8		6		5		4			
	85.5 - 80.6	5	24.7	4	37.3	4	25.6	2		16.6		5	30.2	9	25.5	9	33.3	2		23.1	
	80.5 - 75.6	10		5		7		2				7		7		5		4			
	75.5 - 70.6	15	29.4	4	13.5	2	20.9	0		8.3		5	27.9	3	17.0	2	16.7	0		15.4	
	70.5 - 65.6	5		3		2		1				1		4		1		2			
	65.5 - 60.6	6	12.9	4	10.5	3	11.6	0		4.2		1	4.6	7	18.7	3	9.5	2	1	19.2	
	60.5 - 55.6	5		2		0		0				3		1		4		1	1		
	55.5 - 50.6	2	8.2	2	6.0	0	0.0	0		0.0		2	11.6	1	3.4	0	9.5	0		7.7	
	50.5 - 45.6	4		1		0		3				4		3		1		0			
	45.5 - 40.6	3	8.2	1	3.0	1	2.3	0		12.5		3	16.3	1	6.8	0	2.4	0		0.0	
	40.6 - 35.6	1		1		0		0				0		1		1		0			
	35.5 - 30.6	3	4.7	0	1.5	0	0.0	0		0.0		0	0.0	0	1.7	0	2.4	0		0.0	
	30.5 - 25.6	0		1		0		0				0		0		0		0			
	25.5—	0	0.0	1	3.0	0	0.0	0		0.0		0	0.0	0	0.0	0		0		0.0	
	Total	85		67		43		22	2			43		59		42		24	2		
	Omitted	1		1		0		0	0			0		0		1		0	0		
Parochial School	100 - 95.6	3		5		8		9	1			0		4		5		2	1		
	95.5 - 90.6	2	13.2	3	13.6	11	29.2	8	1	48.7		3	11.5	6	23.8	13	32.7	4	1	23.5	
	90.5 - 85.6	10		13		12		4				2		4		9		7	1		
	85.5 - 80.6	2	31.6	7	33.9	6	27.7	5		23.0		7	34.6	5	21.4	4	23.7	7		44.1	
	80.5 - 75.6	5		8		10		2				7		5		8		4			
	75.5 - 70.6	4	23.7	8	27.2	5	23.1	3		12.8		4	42.3	4	21.4	8	29.0	0		11.8	
	70.5 - 65.6	1		4		3		2	1			0		3		1		2			
	65.5 - 60.6	2	7.9	3	11.9	3	9.2	0		7.7		1	3.8	2	11.9	4	9.1	0		5.9	
	60.5 - 55.6	2		4		1		0				1		2		2		1			
	55.5 - 50.6	3	13.2	2	10.2	2	4.6	1		2.6		0	3.8	3	11.9	0	3.6	2		8.8	
	50.5 - 45.6	1		0		3		0				0		1		1		0			
	45.5 - 40.6	1	5.2	2	3.4	0	4.6	2		5.1		0	0.0	1	2.4	0	1.8	1		2.9	
	40.5 - 35.6	1		0		0		0				1		1		0		0			
	35.5 - 30.6	0	2.6	0	0.0	0	0.0	0		0.0		0	3.8	1	2.4	0	0.0	1		2.9	
	30.5 - 25.6	1		0		0		0				0		0		0		0			
	25.5—	0	2.6	0	0.0	1	1.5	0		0.0		0	0.0	0	0.0	0	0.0	0		0.0	
	Total	38		59		65		36	3			26		42		55		31	3		
	Omitted	0		0		0		1	0			0		1		0		0	0		

TABLE 35
Accuracy of Cancellation. Letter m. 15 years

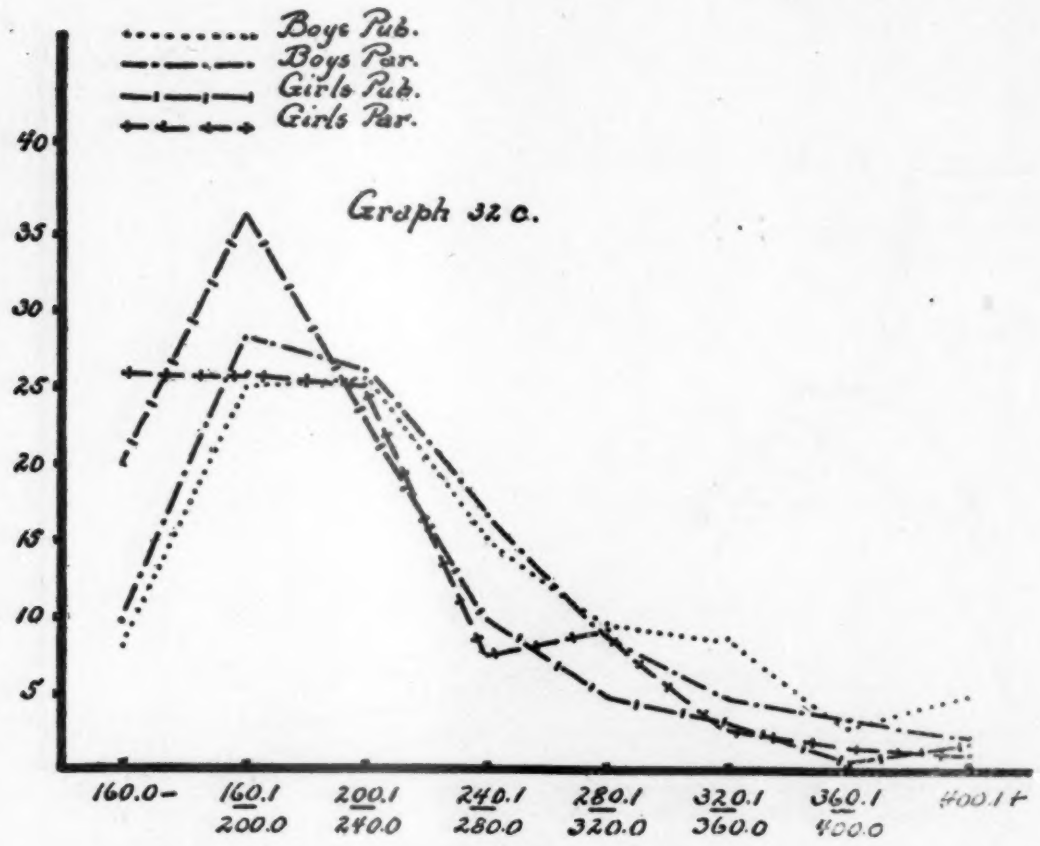
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100 - 95.6	31	38.7	29	47.5	29	67.4	14	1	62.5		16	44.4	30	58.8	21	58.3	16	1	80.9	
	95.5 - 90.6	16	20.0	13	21.3	7	16.3	3	1	16.7		7	19.4	9	17.6	5	13.9	3		14.3	
	90.5 - 85.6	25	31.2	7	11.5	2	4.6	1		4.2		6	16.7	4	7.8	6	16.7	1		4.8	
	85.5 - 80.6	4	5.	4	6.6	3	7.0	3		12.5		1	2.8	3	5.9	1	2.8				
	80.5 - 75.6	0		4		2		0				1		2		2					
	75.5 - 70.6	0	0.0	0	6.6		4.6	1		4.2		0	2.8	3	9.8	0	5.6				
	70.5 - 65.6	0		1								0				1					
	65.5 - 60.6	1	1.2	0	1.6							2	5.6				2.8				
	60.5 - 55.6	2		1								2									
	55.5 - 50.6	1	3.7	2	4.9							1	8.3								
	Total	80		61		43		22	2			36		51		36		20	1		
	Omitted			1										2							
Parochial School	100 - 95.6	12	34.3	23	44.2	23	37.1	18		58.1		12	52.2	18	50.0	31	62.	13	3	57.1	
	95.5 - 90.6	9	25.7	11	21.1	20	32.3	6		19.4		5	21.7	5	13.9	5	10.	6		21.4	
	90.5 - 85.6	5	14.3	10	19.2	9	14.5	5		16.1		2	8.7	6	16.7	12	24.	4		14.3	
	85.5 - 80.6	6	17.1	2	3.8	5	8.1	2		6.4		2	8.7	2	5.6	2	4.	1		3.6	
	80.5 - 75.6	2		3		3						0		2				0			
	75.5 - 70.6	0	5.7	1	7.8	0	4.8					1	4.3	1	8.3			0			
	70.5 - 65.6	1		1		1						1		1				0			
	65.6 - 60.6		2.9	1	3.8	1	3.2						4.3	0	2.8			0			
	60.5 - 55.6			0										0				1		3.6	
	55.5 - 50.6			0										1	2.8						
	Total			1				2				23		36		50		25	3		
	Omitted	35		52		62		31				1		1		1		1			



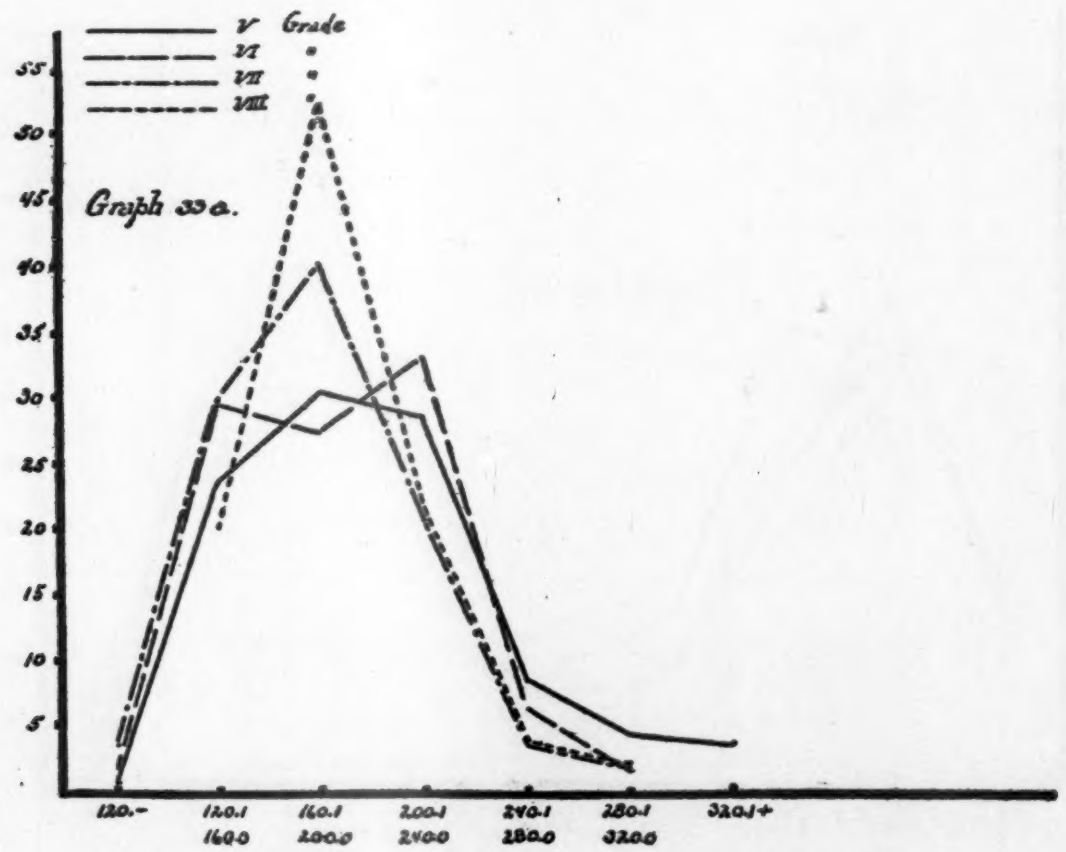
INDEX OF CANCELLATION. LETTER A. 14 YEARS. BOYS.



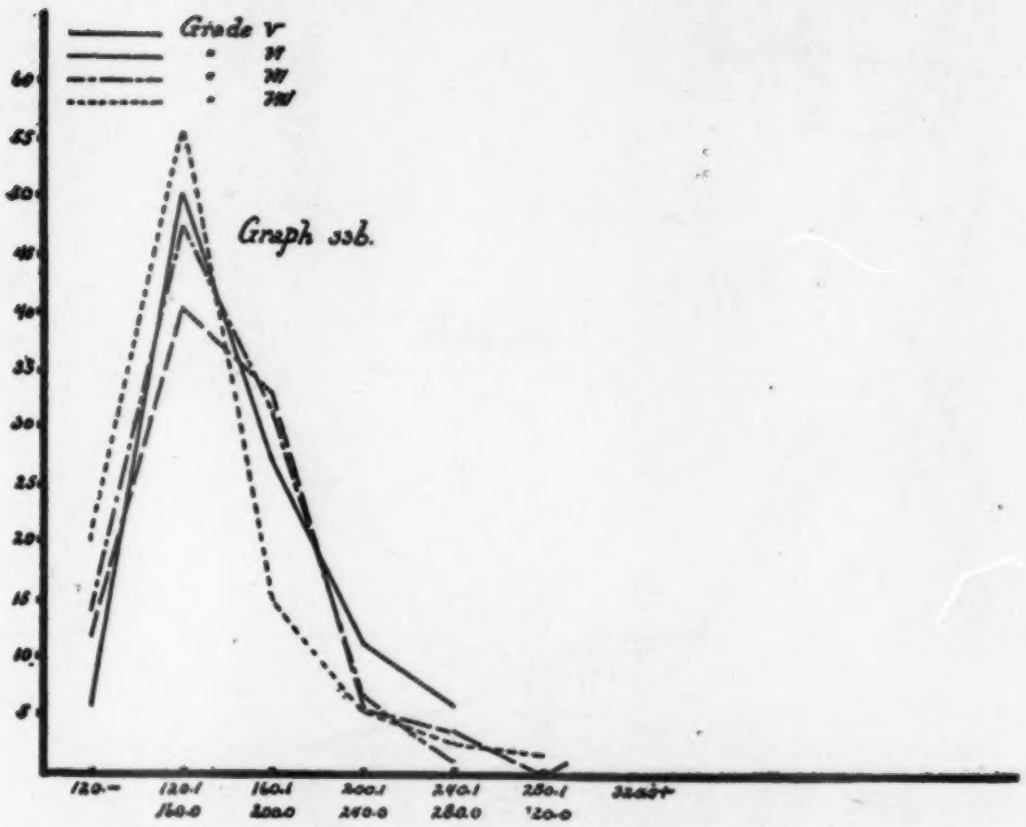
INDEX OF CANCELLATION. LETTER A. 14 YEARS. GIRLS.



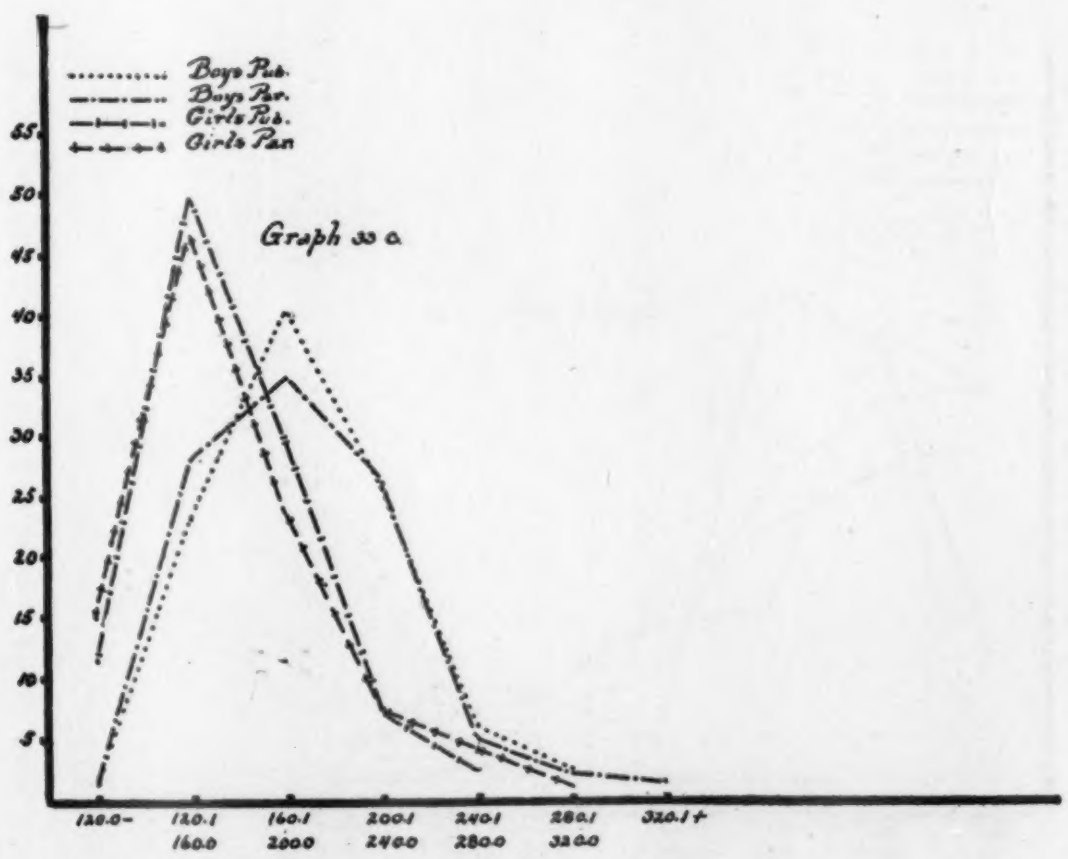
INDEX OF CANCELLATION. LETTER A. 14 YEARS.



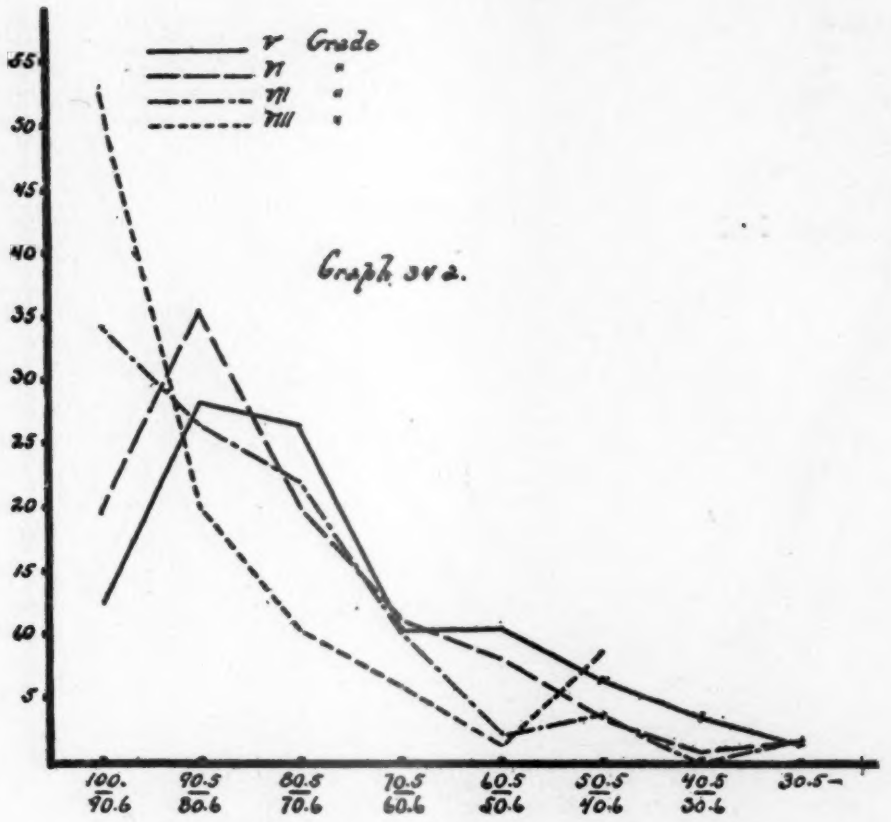
INDEX OF CANCELLATION. LETTER M. 15 YEARS. BOYS.



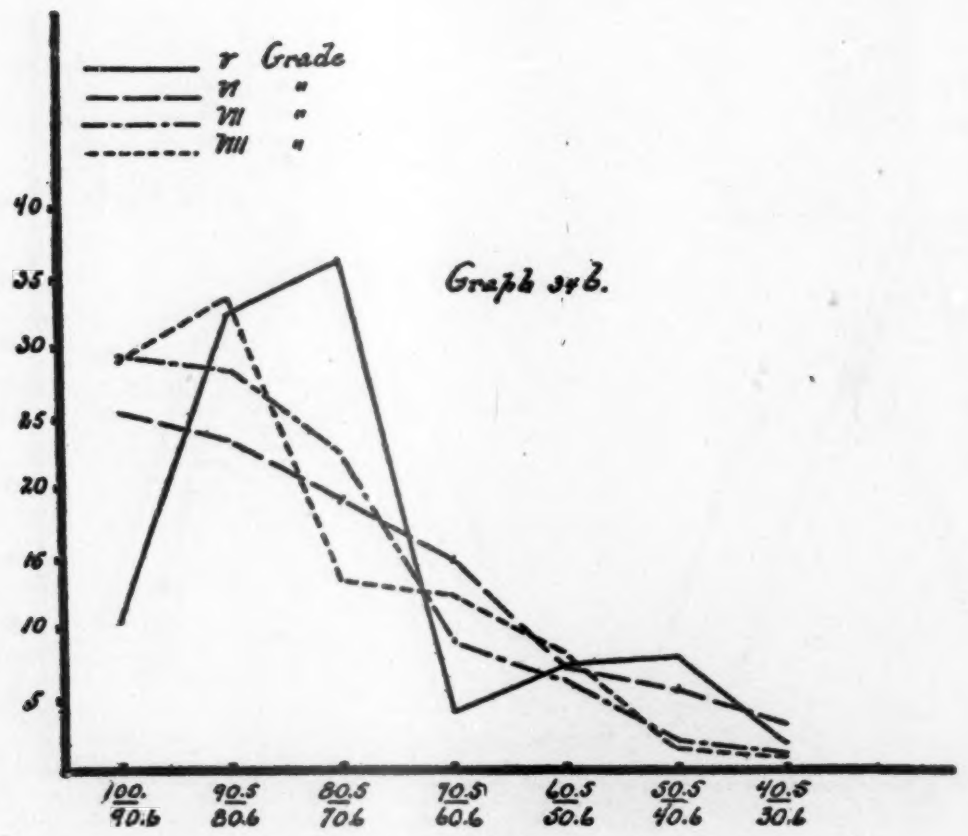
INDEX OF CANCELLATION. LETTER M. 15 YEARS. GIRLS.



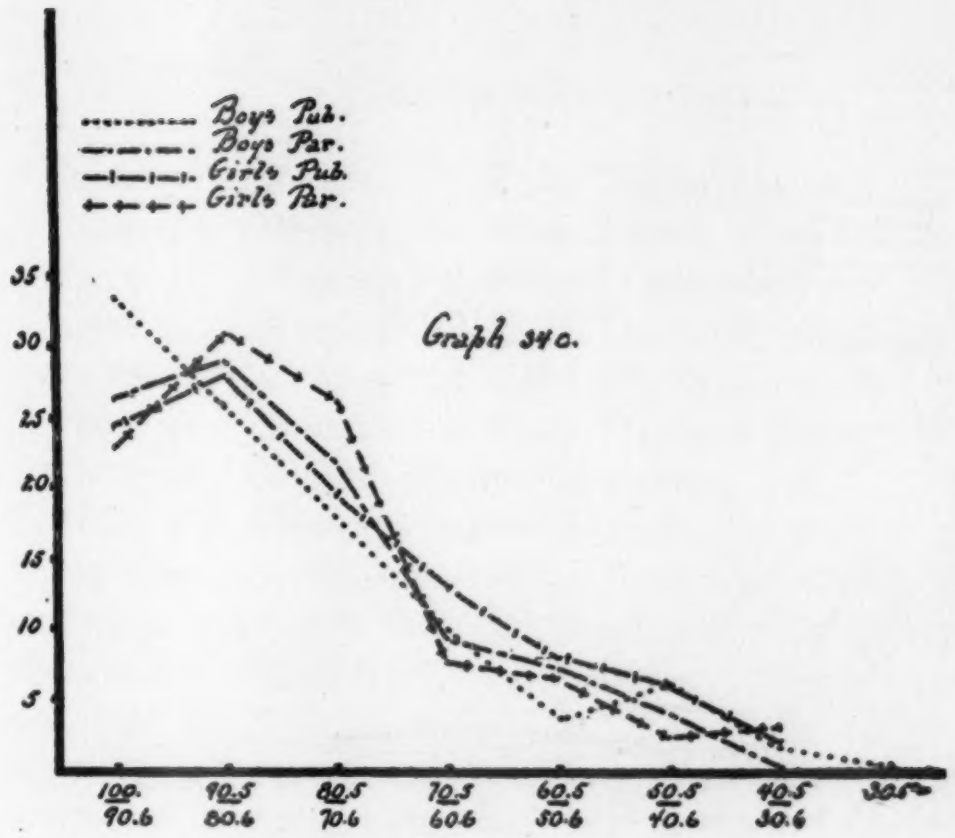
INDEX OF CANCELLATION. LETTER M. 15 YEARS.



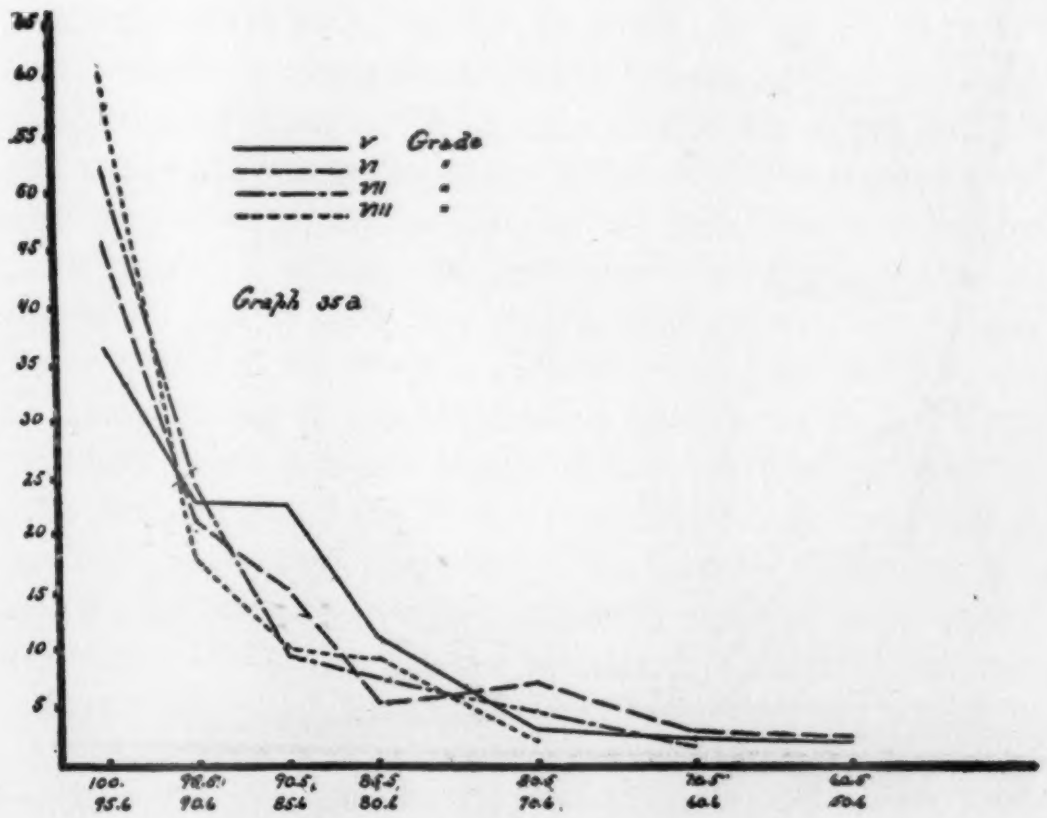
ACCURACY OF CANCELLATION. LETTER A. 14 YEARS. BOYS.



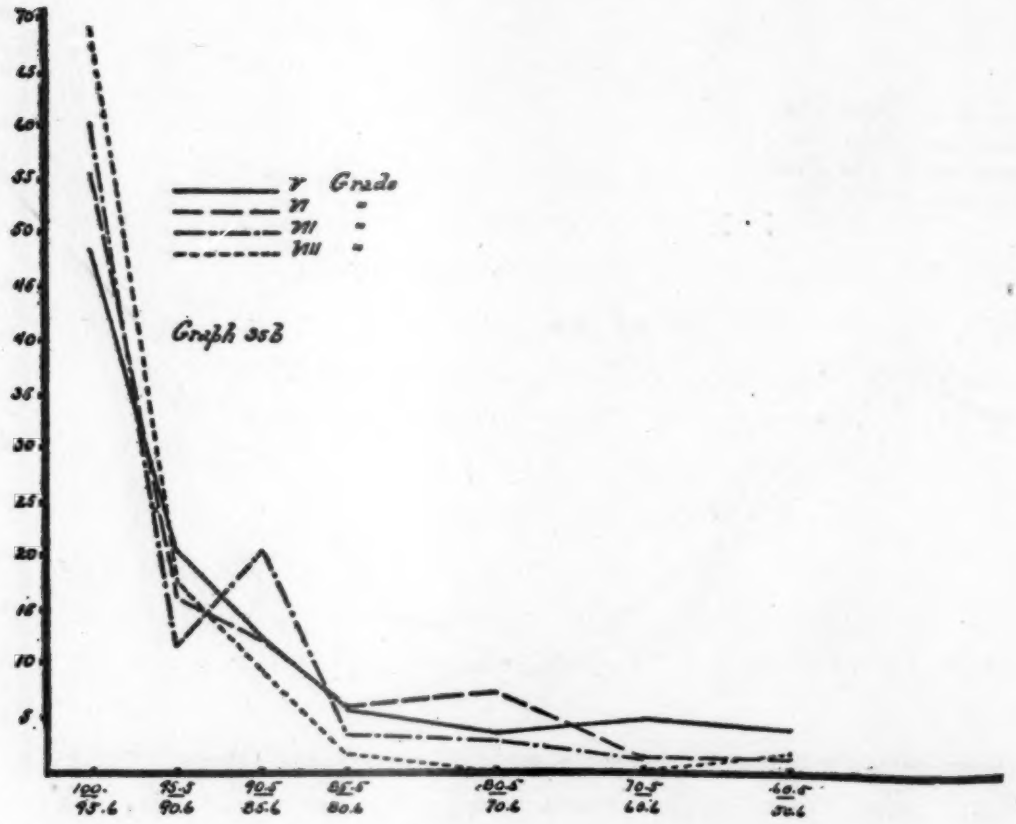
ACCURACY OF CANCELLATION. LETTER A. 14 YEARS. GIRLS.



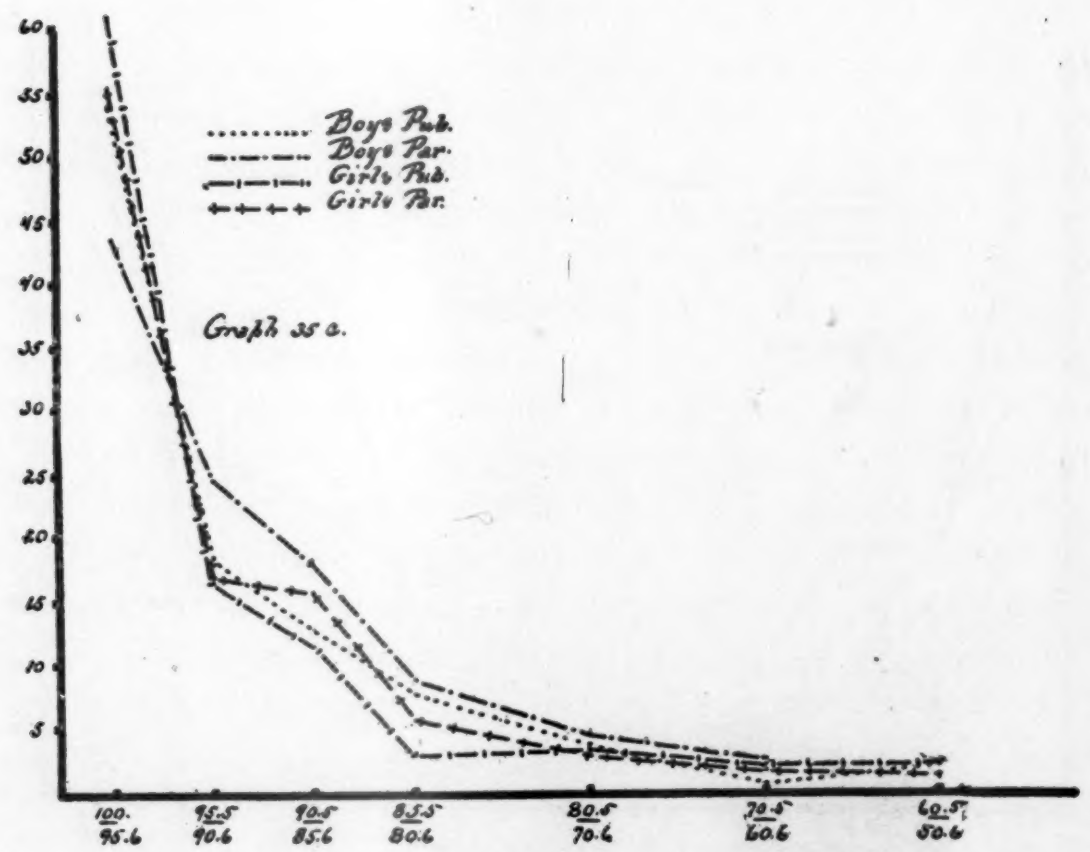
*Accuracy of Cancellation. Letter a. 14 Years.



Accuracy of Cancellation. Letter m. 15 Years. Boys.



ACCURACY OF CANCELLATION. LETTER M. 15 YEARS. GIRLS.



ACCURACY OF CANCELLATION. LETTER M. 15 YEARS.

Section XI—Memory

Table 36. Memory. 7 Place Digits, 14 years.
Table 37. Memory. 7 Place Digits, 15 years.
Table 38. Memory. 8 Place Digits, 14 years
Table 39. Memory. 8 Place Digits, 15 years.
Table 40. Memory. 9 Place Digits, 14 years.
Table 41. Memory. 9 Place Digits, 15 years.
Table 42. Memory Span—14 years.
Table 43. Memory Span—15 years.

Materials—Seven strips of cardboard, one with five digits, two with seven, two with eight, and two with nine, printed on them in large black type. A metronome. (See Whipple's Manual, Test 38a.)

Method of administering the test—The strips of cardboard, in the order indicated, were laid face downward upon the table. The child was supplied with pencil and paper, the metronome conveniently placed, and instructions given as follows:

"On the other side of these cards are some numbers, printed in a row. I am going to turn the card face up and then I want you to read the numbers out loud with me. When we have finished reading them, I will turn the card down again, and I want you to see if you can write the numbers on your paper, just the way they were on the card,—just the same numbers, and in the same order. I will set this instrument ticking (does so at one a second) just to show how fast to read the numbers. Read one every time it ticks, like this (illustrates). The first card is only a sample to see if you understand how to do it, but write the numbers down just the same. There are five numbers on it." The sample card of five is then read, and any errors in procedure on the child's part corrected. The sample card may be used more than once if necessary, since its result is never taken into account. When the test has been correctly performed with the sample, the experimenter proceeds with the other cards, stating each time how many numbers there will be on each one, as—"There will be seven numbers on this card," etc.

There are here two precautions to be observed in the use of the metronome. The first is to time the turning of the cards with the beat of the metronome in such a way that the reading of the first number naturally and unmistakably coincides with a beat. Otherwise the child and the experimenter may begin reading on different beats, and thus disturb the test. The second precaution is for the experimenter to postpone stopping the metronome until the last series has been written by the child. If the metronome is stopped just after the reading, and before the child has written, the sudden cessation of the sound serves as a distraction, and the conditions for the writing of the last series are not uniform with those of the other series.

Method of dealing with results—The evaluation of the results of this test is by no means a simple matter, unless one takes into account only the perfect series, in other words, measures only the memory span. None of the rules so far devised for estimating results is satisfactory. The most serious defect, common to them all, is that they make no allowance for crediting a correct sequence of three or more digits in the wrong part of the series, therefore we adopted this set of rules.

1. For a correct digit in correct place in the series, allow two, giving a value of 14 to a perfect seven-place series, 16 for an eight-place series and 18 for a nine-place series.

2. For any series in which there is but *one* mistake, whether it is an omission, an addition, or a misplacement, take off two only. For instance, if the correct series is 7359624 and the child writes 7396254, count it only one error, since the series can be made perfect by changing the position of one digit—the 5.

3 In series in which there is more than one error,

a. Allow two for every correct digit in the correct position, and one for every correct digit one place removed (except in special case under b).

b. Allow no credit for a correct digit more than one place removed, unless it forms part of a correct sequence of three or more digits. In every such sequence, allow full credit for all except the first digit, which should be given no credit if it is more than one place removed, and half credit if it is one place

removed. For instance, if the correct series is the one already quoted—7359624, and the child writes 7962453, the series should be marked thus,

2 0 2 2 2 0 0
7 9 6 2 4 5 3

giving a value of 8.

All the values for series were at once reduced to percentages, by reference to a table made for each series. A numerical average of the record for the two seven-place, the two eight-place, and the two nine-place series was then recorded. Accordingly the test is reported in four tables, with their corresponding graphs, one for the seven-place series, one for the eight-place, one for the nine-place, and one for the memory span.

Criticisms—While the series of rules for evaluating which we used seemed more nearly fair than any of the usual methods, there were still injustices to be found. Chief of these was the fact that our rules made no provision for the correctness of the last digit in the series, when it was more than one place removed. Next to this in importance was the series in which two digits not next to one another were interchanged in position. Such a series was counted as containing two full errors, though it seemed as though it should have received more credit than a series in which there were two omissions. In view of the great difficulty in estimating a series of digits fairly, and of the large opportunity for guessing on the part of the child, we are inclined to think that the span, if determined with some care, is the most satisfactory measure of such a series.

RESULTS

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	78.8	87.4	80.4	88.4
50 perc.	91.1	94.2	91.7	95.8
75 perc.	96.2	97.8	96.7	98.2
Q	8.7	5.2	8.1	4.9
Limits—				
Lower	39.3	46.0	35.0	57.0
Upper	100	100	100	100

Memory. 7 Place digits, in per cents. Percentiles and limits

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	63.4	69.0	64.5	70.6
50 perc.	74.8	80.8	78.6	83.5
75 perc.	90.7	93.3	92.0	93.9
Q	13.6	12.1	13.7	11.6
Limits—				
Lower	22.0	9.4	25.0	22.0
Upper	100	100	100	100

Memory. 8 Place digits, in per cents. Percentiles and limits

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	55.4	56.6	55.9	58.7
50 perc.	66.1	69.5	68.2	71.5
75 perc.	80.7	84.3	82.2	84.7
Q	12.6	13.8	13.1	13.0
Limits—				
Lower	11.0	17.0	22.0	22.0
Upper	100	100	100	100

Memory. 9 Place digits, in per cents. Percentiles and limits

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	7.0	7.3	7.1	7.3
50 perc.	7.8	8.1	7.9	8.1
75 perc.	8.8	9.1	9.0	9.0

Memory Span. Percentiles

Correlation with school grade.

Graph 36a—7 Place Digits, Boys, 14 years,
Graph 36b—7 Place Digits, Girls, 14 years,
Graph 37a—7 Place Digits, Boys, 15 years,
Graph 37b—7 Place Digits, Girls, 15 years,
Graph 38a—8 Place Digits, Boys, 14 years,

Graph 38b—8 Place Digits, Girls, 14 years,
Graph 39a—8 Place Digits, Boys, 15 years,
Graph 39b—8 Place Digits, Girls, 15 years,
Graph 40a—9 Place Digits, Boys, 14 years,
Graph 40b—9 Place Digits, Girls, 14 years,
Graph 41a—9 Place Digits, Boys, 15 years,
Graph 41b—9 Place Digits, Girls, 15 years,
Graph 42a—Span—Boys, 14 years,
Graph 42b—Span—Girls, 14 years,
Graph 43a—Span—Boys, 15 years,
Graph 43b—Span—Girls, 15 years.

The positive correlation with school grade is marked in every graph,—for seven, eight and nine-place digits and for the span—for both sexes and at both ages. Indeed there is only one graph in the whole series which shows the slightest deviation from a perfect correlation, and that is the graph for fifteen-year old girls, seven-place digits (37b) in which the fifth grade is superior to the sixth. In the case of the boys, the correlation is even more marked in the fifteen-year graphs than in the fourteen-year. For the girls the correlation is about the same in amount at the two ages.

Comparisons of Sex and School.

Graph 36c—Memory—7 Place Digits, 14 years,
Graph 37c—Memory—7 Place Digits, 15 years,
Graph 38c—Memory—8 Place Digits, 14 years,
Graph 39c—Memory—8 Place Digits, 15 years,
Graph 40c—Memory—9 Place Digits, 14 years,
Graph 41c—Memory—9 Place Digits, 15 years,
Graph 42c—Memory Span, 14 years,
Graph 43c—Memory Span, 15 years.

Sex—Though the differences between the sexes are small, the percentiles for the seven-, eight- and nine-place series of digits are in every case a little higher for the girls than for the boys. The same is true of the span at fourteen years, though there is no difference in the percentiles for the span at fifteen years.

The graphs for the sex and school groups show only small differences. The most consistent thing about them is the supe-

riority of the parochial school girls. Sex graphs plotted separately, would show a slight superiority of the girls, due chiefly to the parochial school group.

School—The difference between the two kinds of school is too small to be of much significance. It is on the whole slightly in favor of the parochial school, and is again chiefly due to the superior rank of the parochial school girls.

Age—All of the graphs and tables of percentiles show a gain in memory in the fifteen-year series for both sexes, a gain which varies from 2 to 6 per cent.

TABLE 36

Memory. 7 Place Digits. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100 - 95.6	13	15.1	18	26.5	15	35.7	13	1	58.3		8	18.6	15	25.4	11	27.5	12	1	52.0	
	95.5 - 90.6	21	24.4	19	27.9	9	21.4	3	1	16.7		9	20.9	13	22.0	8	20.0	6		24.0	
	90.5 - 85.6	11	12.8	11	16.2	12	28.6	2		8.3		4	9.3	15	25.4	10	25.0	2		8.0	
	85.5 - 80.6	3		2		0		1				3		1		1		1			
	80.5 - 75.6	13	18.6	2	5.8	1	2.4	2		12.5		2	11.7	5	10.2	3	10.0	1		8.0	
	75.5 - 70.6	9		7		3		1				3		2		2		0	1		
	70.5 - 65.6	1	11.7	1	11.8	0	7.1	0		4.2		4	16.3	3	8.5	2	10.0	1		8.0	
	65.5 - 60.6	7		2		2		0				3		2		2		0			
	60.5 - 55.6	0	8.1	1	4.4	0	4.8	0		0.0		2	11.7	2	6.8	0	5.0	0		0.0	
	55.5 - 50.6	2		0		0		0				1		0		0		0			
	50.5 - 45.6	5		4		0		0				2		1		1		0			
	45.5 - 40.6	1		0		0		0				1		0		0		0			
	40.5—	0	9.3	1	7.4	0	0.0	0		0.0		1	11.6	0	1.7	0	2.5	0		0.0	
	Total	86		68		42		22	2			43		59		40		23	2		
	Omitted	0		0		1		0	0			0		0		3		1	1		
Parochial School	100 - 95.6	3	8.1	17	29.3	21	32.8	16	1	42.5		5	20.0	10	23.3	25	45.5	16	1	50.0	
	95.5 - 90.6	9	24.3	14	24.1	16	25.0	10		25.0		4	16.0	11	25.6	13	23.6	8	2	29.4	
	90.5 - 85.6	11	29.7	10	17.2	9	14.1	4		10.0		2	8.0	6	14.0	7	12.7	4		11.8	
	85.5 - 80.6	0		3		3		1				0		5		1		2			
	80.5 - 75.6	2	5.4	5	13.8	4	11.0	1	2	10.0		4	16.0	3	18.6	3	7.3	1		8.8	
	75.5 - 70.6	5		2		6		1				6		4		1		0			
	70.5 - 65.6	1	16.2	1	5.2	2	12.4	1		5.0		2	32.0	2	13.9	2	5.4	0		0.0	
	65.5 - 60.6	2		3		2		0				2		0		1		0			
	60.5 - 55.6	1	8.1	0	5.2	0	3.0	1		2.5		0	8.0	1	2.3	0	1.8	0		0.0	
	55.5 - 50.6	3		2		0		0				0		0		0		0			
	50.5 - 45.6	0		0		1		2				0		1		2		0			
	45.5 - 40.6	0		1		0		0				0		0		0		0			
	40.5—	0	8.1	0	5.2	0	1.6	0		5.0		0	0.0	0	2.3	0	3.6	0		0.0	
	Total	37		58		64		37	3			25		43		55		31	3		
	Omitted	1		1		1		0	0			1		0		0		0	0		

TABLE 37
Memory. 7 Place Digits. 15 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100 - 95.6	19	25.3	30	51.7	21	50.	15	1	66.7		14	41.2	18	36.	22	61.1	17	1	85.7	
	95.5 - 90.6	16	21.3	14	24.1	10	23.8	4	1	20.8		4	11.8	12	24.	5	13.9	3		14.3	
	90.5 - 85.6	16	21.3	8	13.8	6	14.3	1		4.2		9	26.5	9	18.	4	11.1				
	85.5 - 80.6	2		1		1		0				1		1		1					
	80.5 - 75.6	6	10.7	2	5.2	1	4.7	0		0.0		3	11.8	5	12.	0	2.8				
	75.5 - 70.6	8		1		3		1				0		2		3					
	70.5 - 65.6	1	12.0	0	1.7		7.1			4.2		1	2.9	0	4.	0	8.3				
	65.5 - 60.6	4		1								2		1		1					
	60.5 - 50.6	3	9.3	1	3.4			1		4.2			5.9	2	6.	0	2.8				
	Total	75		58		42		22	2			34		50		36		20	1		
	Omitted	5		4		1						2		3							
Parochial School	100 - 95.6	11	31.4	21	41.2	30	50.	20		62.5		12	52.2	11	29.7	31	60.8	18	3	75.	
	95.5 - 90.6	6	17.1	8	15.7	10	16.7	6		18.7		4	17.4	4	10.8	7	13.7	3		10.7	
	90.5 - 85.6	6	17.1	10	19.6	10	16.7	5		15.6		4	17.4	14	37.9	5	9.8	3		10.7	
	85.5 - 80.6	3		3		3						1		0		2					
	80.5 - 75.6	4	20.0	5	15.7	2	8.3			0.0		0	4.3	3	8.1	4	11.8				
	75.5 - 70.6	3		1		2						1		2		1					
	70.5 - 65.6	1	11.4	0	1.9	1	5.0			0.0		1	8.7	1	8.1	0	2.0	1		3.6	
	65.5 - 60.6	0		2		2		1						1		1					
	60.5 - 50.6	1	2.9	1	5.9	0	3.3	32		3.1				1	5.4	0	2.0				
	Total	35		51		60						23		37		51		25	3		
	Omitted			2		2		1				1						1			

TABLE 38

Memory. 8 Place Digits. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
PUBLIC SCHOOL	10.0 - 95.6	7		6		7		7				3		6		4		8	1		
	95.5 - 90.6	7	16.2	9	22.4	10	39.5	4	1	50.0		4	16.3	10	27.1	7	27.5	2		42.3	
	90.5 - 85.6	4		4		5		0				1		2		3		2			
	85.5 - 80.6	6	11.7	9	19.4	0	11.6	2		9.1		3	9.3	9	18.6	2	12.5	3		19.2	
	80.5 - 75.6	1		4		3		1				2		4		1		1			
	75.5 - 70.6	13	16.2	8	16.4	4	16.3	4	1	22.7		6	18.6	7	18.6	10	27.5	5		23.1	
	70.5 - 65.6	14		9		5		2				2		4		4		2	1		
	65.5 - 60.6	5	22.1	4	19.4	4	20.9	0		9.1		4	13.9	2	10.2	2	15.0	0		11.5	
	60.5 - 55.6	11		5		3		2				4		5		4		0			
	55.5 - 50.6	2	15.1	2	10.4	1	9.3	0		9.1		4	18.6	3	13.6	0	10.0	0		0.0	
	50.5 - 45.6	10		4		1		0				6		2		2		0			
	45.5 - 40.6	2	13.9	3	10.4	0	2.3	0		0.0		3	20.9	3	8.5	0	5.0	0		3.8	
	40.5—	4	4.6	1	1.5	0	0.0	0		0.0		1	2.3	2	3.4	1	2.5	1		0.0	
	Total	86		68		43		22	2			43		59		40		24	2		
	Omitted	0		0		0		0	0			0		0		3		0	1		
PAROCHIAL SCHOOL	100 - 95.6	1		7		6		9	1			0		5		8		11	1		
	95.5 - 90.6	3	10.8	6	22.1	10	25.0	7		43.5		2	8.0	6	25.5	7	27.2	8	1	61.8	
	90.5 - 85.6	1		4		9		4				2		6		7		3	1		
	85.5 - 80.6	3	10.8	9	22.1	6	23.4	5	1	25.7		6	32.0	5	25.5	6	23.6	2		17.7	
	80.5 - 75.6	2		3		4		3				0		1		5		0			
	75.5 - 70.6	4	16.2	8	18.7	9	20.2	3		15.4		3	12.0	3	9.3	8	23.6	2		5.9	
	70.5 - 65.6	5		7		6		3				4		1		6		1			
	65.5 - 60.6	3	21.6	0	11.8	4	15.6	0		7.7		2	24.0	1	4.6	5	20.0	1		5.9	
	60.5 - 55.6	4		5		7		1				3		7		1		0			
	55.5 - 50.6	2	16.2	0	8.5	1	12.5	0		2.6		0	12.0	1	18.6	0	1.8	2		5.9	
	50.5 - 45.6	4		5		2		0				1		3		2		0			
	45.5 - 40.6	1	13.5	3	13.6	0	3.0	1		2.6		2	12.0	2	11.6	0	3.6	1		2.9	
	40.5—	4	10.8	2	3.4	0	0.0	1		2.6		0	0.0	2	4.6	0	0.0	0			
	Total	37		59		64		37	2			25		43		55		31	3		
	Omitted	1		0		1		0	1			1		0		0		0	0		

TABLE 39

Memory. 8 Place Digits. 15 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100 - 95.6	7		7		11		9	1			6		5		9		7	1		
	95.5 - 90.6	7	18.9	4	18.9	4	35.7	5	1	66.7		4	29.4	6	22.	8	47.2	2		47.6	
	90.5 - 85.6	5		6		3		3				0		4		5		1			
	85.5 - 80.6	4	12.2	9	25.9	5	19.0	2		20.8		2	5.9	10	28.	2	19.4	5		28.6	
	80.5 - 75.6	7		2		3		0				3		3		1		0			
	75.5 - 70.6	9	21.6	15	29.3	8	26.2	0		0.0		2	14.7	5	16.	6	19.4	3		14.3	
	70.5 - 65.6	7		4		5		1				4		3		1		0			
	65.5 - 60.6	2	12.2	2	10.3	0	11.9	1		8.3		0	11.8	3	12.	0	2.8	0		0.0	
	60.5 - 55.6	12		5		0		1				4		5		0		1			
	55.5 - 50.6	4	21.6	0	8.6	0	0.0			4.2		2	17.6	0	10.	0	0.0	0		4.7	
	50.5 - 45.6	3		2		2						2		2		3		1			
	45.5 - 40.6	2	6.8	1	5.2	1	7.1					4	17.6	4	12.	0	8.3	0		4.7	
	40.5—	5	6.8	1	1.7	0						1	2.9	0		1	2.8	0			
	Total	74		58		42		22	2			34		50		36		20	1		
	Omitted	6		4		1						2		3							
Parochial School	100 - 95.6	1		8		13		14				3		4		9		8	2		
	95.5 - 90.6	4	14.3	5	25.5	11	40.0	8		68.7		4	30.4	5	24.3	8	33.3	8	1	67.8	
	90.5 - 85.6	3		8		7		1				2		6		7		2			
	85.5 - 80.6	2	14.3	6	27.4	3	16.7	2		9.4		3	21.7	2	21.6	1	15.7	5		25.0	
	80.5 - 75.6	3		5		5		0				3		3		5		0			
	75.5 - 70.6	5	22.9	6	21.6	9	23.3	3		9.4		5	34.8	3	16.2	11	31.4	0		0.0	
	70.5 - 65.6	8		7		7		1				1		7		4		1			
	65.5 - 60.6	4	34.3	2	17.6	1	13.3	1		6.2		0	4.3	0	18.9	0	7.8	1		7.1	
	60.5 - 55.6	2		2		1		1				0		3		3					
	55.5 50.6	1	8.6	1	5.9	1	3.3			3.1		1	4.3	1	10.8	2	9.8				
	50.5 - 45.6	2		0		1						1		3		1					
	45.5 - 40.6	0	5.5	1	2.0	0	1.7					0	4.3	0	8.1	0	2.0				
	40.5—	0		0		1	1.7	1				0		0		0					
	Total	35		51		60		32				23		37		51		25	3		
	Omitted			2		2		1				1						1			

TABLE 40

Memory. 9 Place Digits. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100 - 95.6	3		1		4		3				1		1		1		0			
	95.5 - 90.6	4	8.1	4	7.4	3	16.3	5		33.3		4	11.6	6	11.9	2	7.5	1		4.0	
	90.5 - 85.6	1		3		4		0				1		3		2		6			
	85.5 - 80.6	3	4.7	8	16.2	6	23.2	1		4.2		1	4.6	4	11.9	1	7.5	3		36.0	
	80.5 - 75.6	2		3		5		2	1			3		1		2		2			
	75.5 - 70.6	8	11.6	9	17.6	6	25.5	4		29.2		3	14.0	5	10.2	7	22.5	5	1	32.0	
	70.5 - 65.6	6		6		2		0				3		11		8		1			
	65.5 - 60.6	15	24.4	10	23.5	5	16.2	0		0.0		2	11.6	7	30.5	6	35.0	3		16.0	
	60.5 - 55.6	9		7		3		2	1			9		3		3		1			
	55.5 - 50.6	11	23.3	4	16.2	1	9.3	0		12.5		1	23.2	3	10.2	1	10.0	0	1	8.0	
	50.5 - 45.6	12		3		1		3				6		7		0		0			
	45.5 - 40.6	4	18.5	2	7.3	3	9.3	1		16.7		4	23.2	4	18.7	3	7.5	0		0.0	
	40.5 - 35.6	5		3		0		0				1		1		1		1			
	35.5 - 30.6	0	5.8	2	7.3	0	0.0	1		4.2		2	6.9	3	6.8	3	10.0	0		4.0	
	30.5—	3	3.5	3	4.4	0	0.0	0		0.0		2	4.6	0	0.0	0	0.0	0		0.0	
	Total	86		68		43		22	2			43		59		40		23	2		
	Omitted	0		0		0		0	0			0		0		3		1	1		
Parochial School	100 - 95.6	0		2		5		5	1			0		2		2		5			
	95.5 - 90.6	0	0.0	4	10.3	1	9.4	2		20.0		0	0.0	1	6.9	10	22.2	9		41.2	
	90.5 - 85.6	2		2		6		3	1			2		2		2		3			
	85.5 - 80.6	2	10.8	5	12.0	5	17.2	7		27.5		1	12.0	3	11.6	6	14.8	2	1	17.6	
	80.5 - 75.6	0		4		3		1				3		2		3		1			
	75.5 - 70.6	6	16.2	6	17.2	6	14.1	3	1	12.5		1	16.0	5	16.2	9	22.2	2	1	11.7	
	70.5 - 65.6	4		6		6		8				1		6		6		0	1		
	65.5 - 60.6	1	13.5	7	22.3	8	21.9	2		25.0		4	20.0	4	23.2	6	22.2	2		8.8	
	60.5 - 55.6	5		9		12		4				4		1		5		3			
	55.5 - 50.6	4	24.3	2	19.0	3	23.4	1		12.5		2	24.0	1	4.6	0	9.3	4		20.6	
	50.5 - 45.6	5		7		1		1				1		7		3		0			
	45.5 - 40.6	3	21.6	2	15.5	5	9.4	0		2.5		3	16.0	4	25.6	1	7.3	0		0.0	
	40.5 - 35.6	2		0		0		0				0		4		0		0			
	35.5 - 30.6	1	8.1	2	3.4	1	1.6	0		0.0		1	4.8	0	9.3	0	0.0	0		0.0	
	30.5—	2	5.4	0	0.0	2	3.0	0		0.0		2	8.0	1	2.3	1	1.8	0		0.0	
	Total	37		58		64		37	3			25		43		54		31	3		
	Omitted	1		1		1		0	0			1		0		1		0	0		

TABLE 41

Memory. 9 Place Digits. 15 years

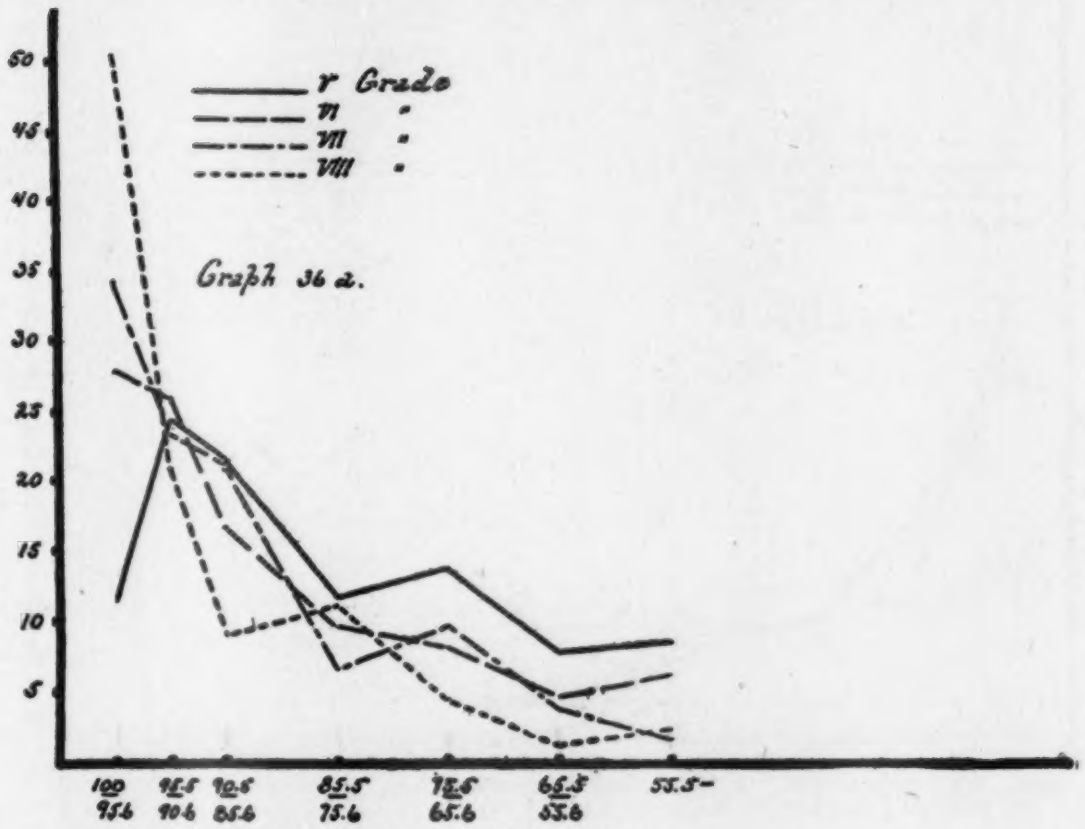
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100 - 95.6	2		4		2		3	1			1		1		3		2			
	95.5 - 90.6	2	5.3	5	15.5	6	19.0	2		25.0		2	8.8	6	14.	1	11.4	3		23.8	
	90.5 - 85.6	3		2		3		3				1		4		3		3			
	85.5 - 80.6	5	10.7	7	15.5	5	19.0	4		29.2		5	17.6	2	12.	3	17.1	2	1	28.6	
	80.5 - 75.6	1		4		2		1				0		2		3		4			
	75.5 - 70.6	10	14.7	5	15.5	3	11.9	4		20.8		4	11.8	2	8.	3	17.1	3		33.3	
	70.5 - 65.6	8		6		6		0	1			5		7		2		0			
	65.5 - 60.6	8	21.3	5	19.0	4	23.8	3		16.7		0	14.7	7	28.	4	17.1	1		4.8	
	60.5 - 55.6	6		9		4		1				6		7		7		1			
	55.5 - 50.6	7	17.3	1	17.2	1	11.9	0		4.2		1	20.6	3	20.	1	22.9	0		4 8	
	50.5 - 45.6	12		3		3		1				4		5		2		0			
	45.5 - 40.6	3	20.0	6	15.5	2	11.9			4.2		2	17.6	2	14.	1	8.6	0			
	40.5—	8	10.7	1	1.7	1	2.4					3	8.8	2	4.	2	5.7	1		4.8	
	Total	75		58		42		22	2			34		50		35		20	1		
	Omitted	5		4		1						2		3		1					
Parochial School	100 - 95.6	0		3		4		4				0		2		4		1			
	95.5 - 90.6	2	5.7	1	7.8	6	16.7	7		34.4		1	4.3	1	8.1	5	17.6	4	2	25.0	
	90.5 - 85.6	1		6		7		6				1		3		5		3	1		
	85.5 - 80.6	3	11.4	2	15.7	5	20.0	4		31.2		5	26.1	6	24.3	8	25.5	5		32.1	
	80.5 - 75.6	2		1		0		2				1		0		7		1			
	75.5 - 70.6	4	17.1	5	11.8	14	23.3	2		12.5		3	17.4	4	10.8	3	19.6	4		17.8	
	70.5 - 65.6	1		7		7		1				2		4		1		2			
	65.5 - 60.6	1	5.7	5	23.5	6	21.7	2		9.4		4	26.1	4	21.6	9	19.6	2		14.3	
	60.5 - 55.6	5		9		4		2				2		1		4		1			
	55.5 - 50.6	4	25.7	5	27.4	3	11.7	0		6.2		1	13.0	3	10.8	2	11.8	1		7.1	
	50.5 - 45.6	4		5		2		2				1		5		1		0			
	45.5 - 40.6	3	20.0	1	11.8	1	5.0			6.2		0	4.3	2	18.9	1	3.9	0		0.0	
	40.5—	5	14.3	1	1.9	1	1.7					2	8.7	2	5.4	1	1.9	1		3.6	
	Total	35		51		60		32				23		37		51		25	3		
	Omitted			2		2		1				1						1			

TABLE 42
Memory Span. 14 years

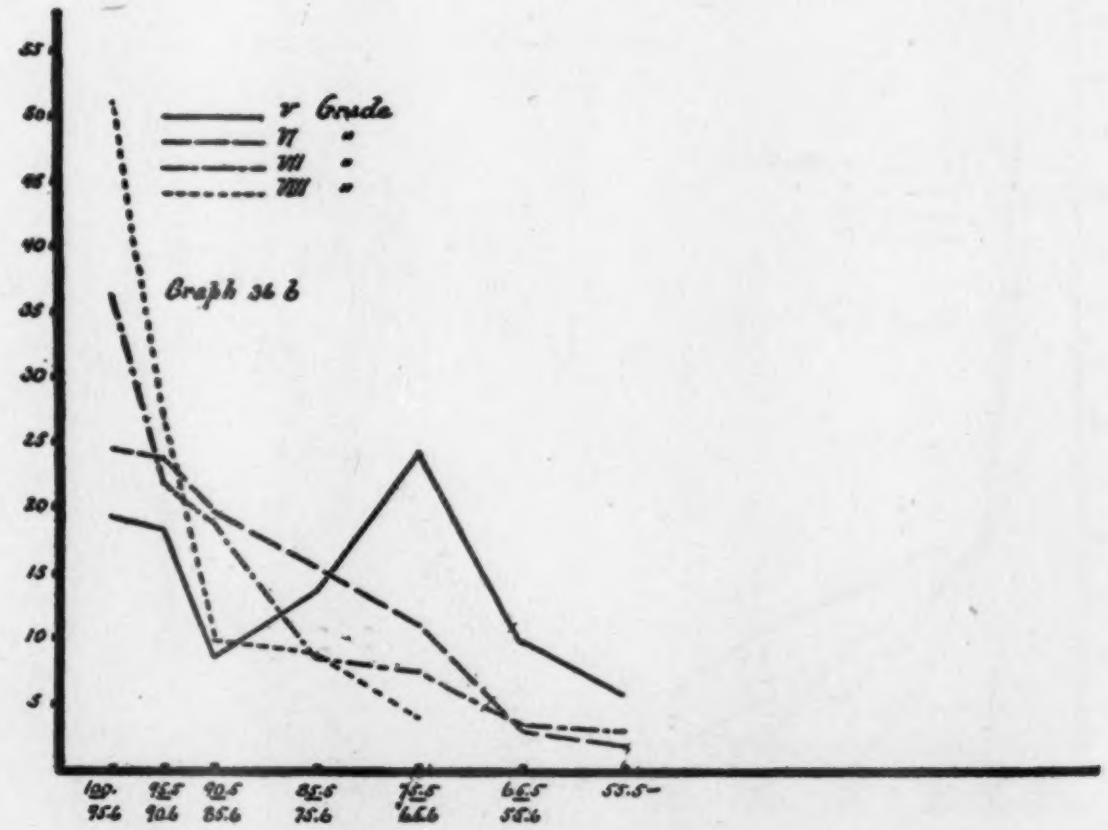
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
PUBLIC	Span	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
	Below 7	28	32.6	15	22.1	8	18.6	5		20.8		17	39.5	15	25.4	5	12.5	2	1	12	
	7	35	40.7	25	36.8	14	32.5	3	1	16.7		14	32.5	20	33.9	16	40.0	6		24	
	8	11	12.8	17	25.0	7	16.3	4	1	20.8		4	9.3	11	18.6	13	32.5	8		32	
	9	12	13.9	11	16.2	14	32.5	10		41.7		8	18.6	13	22.0	6	15.0	7	1	32	
	Total	86		68		43		22	2			43		59		40		23	2		
	Omitted	0		0		0		0	0			0		0		3		1	1		
PAROCHIAL	Below 7	15	40.5	16	27.1	13	20.3	5		12.5		10	40.0	10	23.2	11	20.0	1		2.9	
	7	12	32.4	16	27.1	27	42.2	6		15.0		6	24.0	15	34.9	14	25.4	5		14.7	
	8	8	21.6	15	25.4	14	21.9	10	1	27.5		6	24.0	11	25.6	11	20.0	6	3	26.5	
	9	2	5.4	12	20.3	10	15.6	16	2	45.0		3	12.0	7	16.3	19	34.5	19		55.9	
	Total	37		59		64		37	3			25		43		55		31	3		
	Omitted	1		0		1		0	0			1		0		0			0		

TABLE 43
Memory Span. 15 years

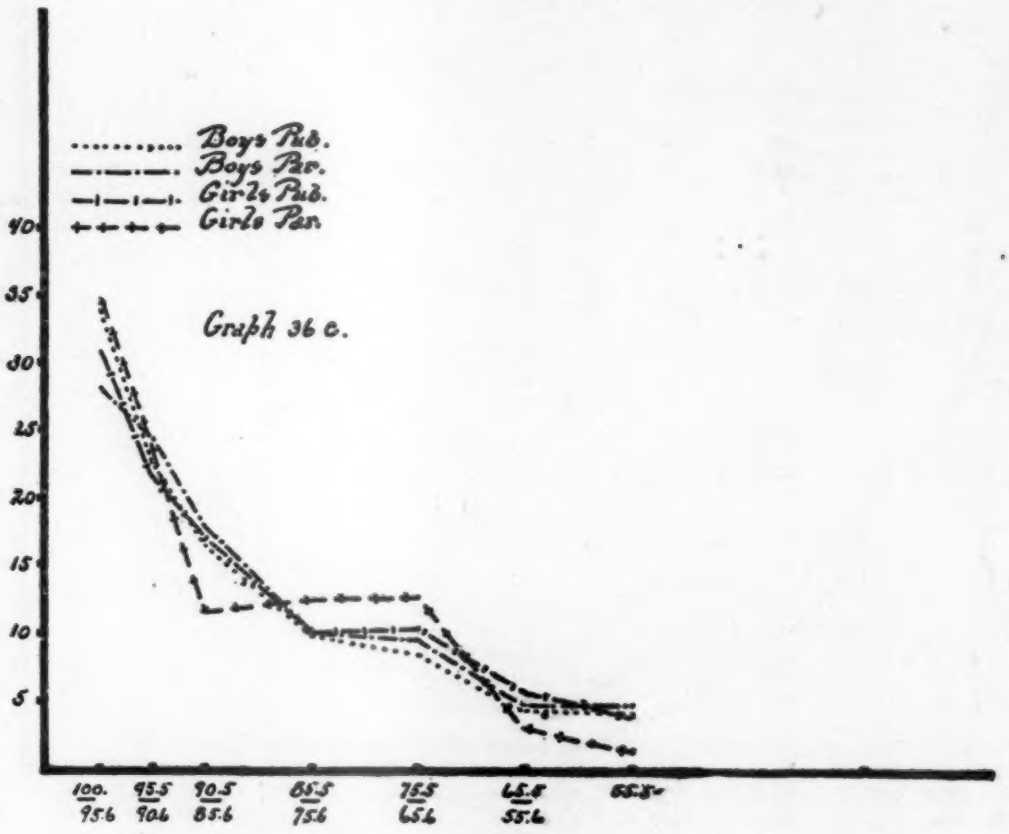
School	Grade	Boys												Girls											
		V		VI		VII		VIII	IX		VIII and IX			V		VI		VII		VIII	IX		VIII and IX		
PUBLIC	Span	No.	%	No.	%	No.	%	No.	No.		%			No.	%	No.	%	No.	%	No.	No.		%		
	Below 7	23	30.7	4	6.9	1	2.4	1			4.2			11	32.3	7	14.	1	2.9	0					
	7	24	32.0	27	46.5	15	35.7	3			12.5			11	32.3	24	48.	14	40.0	4			19.0		
	8	16	21.3	15	25.9	14	33.3	10	1		45.8			6	17.6	10	20.	11	31.4	7	1		38.1		
	9	12	16.0	12	20.7	12	28.6	8	1		37.5			6	17.7	9	18.	9	25.7	9			42.9		
	Total	75		58		42		22						34		50		35		20					
	Omitted	5		4		1								2		3		1							
PAROCHIAL	Below 7	9	25.7	12	23.5	5	8.3	1			3.1			2	8.7	8	21.6	6	11.8	1			3.6		
	7	19	54.3	16	31.4	20	33.3	3			9.4			11	47.8	13	35.1	18	35.3	4			14.3		
	8	3	8.6	11	21.6	10	16.7	10			31.2			9	39.1	6	16.2	11	21.6	11	1		42.8		
	9	4	11.4	12	23.5	25	41.7	18			56.2			1	4.3	10	27.0	16	31.4	9	2		39.3		
	Total	35		51		60		32						23		37		51		25					
	Omitted			2		2		1						1						1					



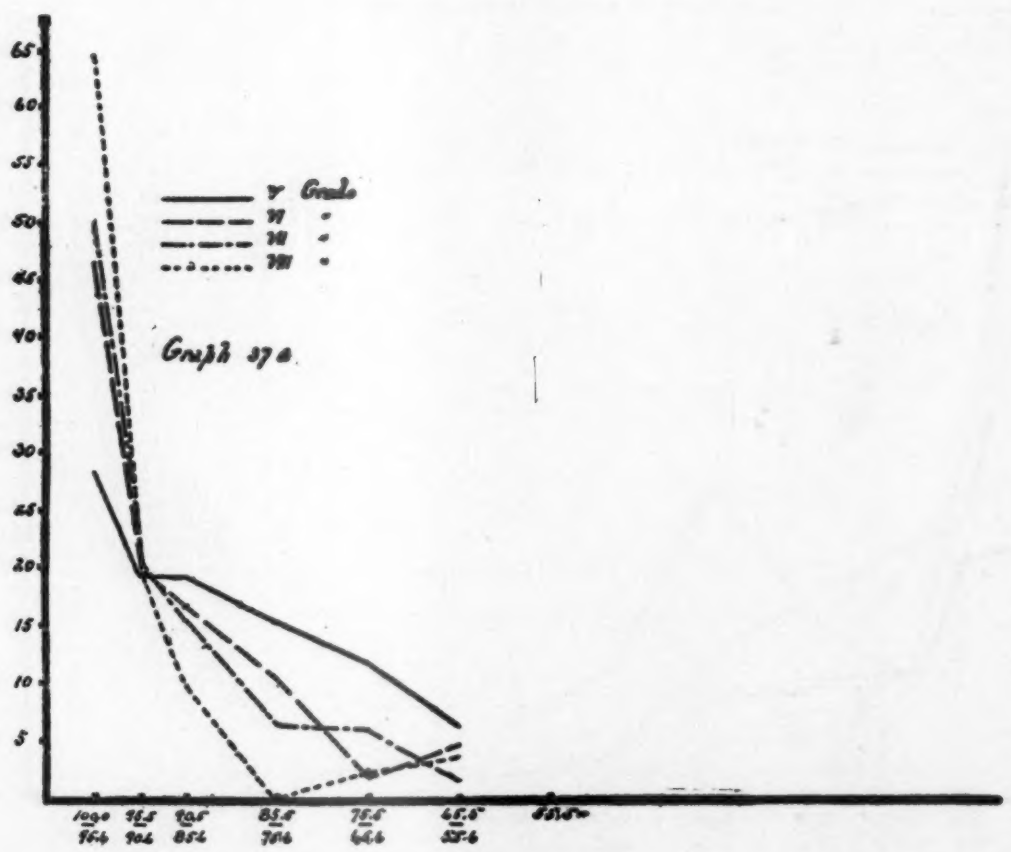
MEMORY. 7 PLACE DIGITS. 14 YEARS. BOYS.



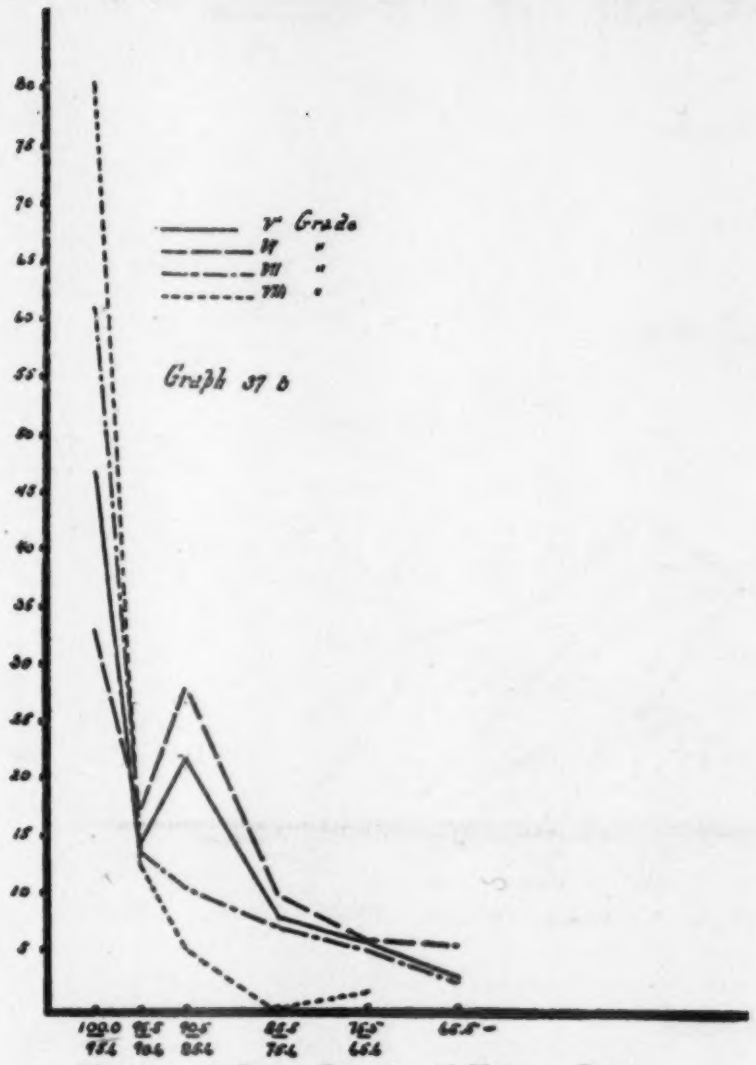
MEMORY. 7 PLACE DIGITS. 14 YEARS. GIRLS.



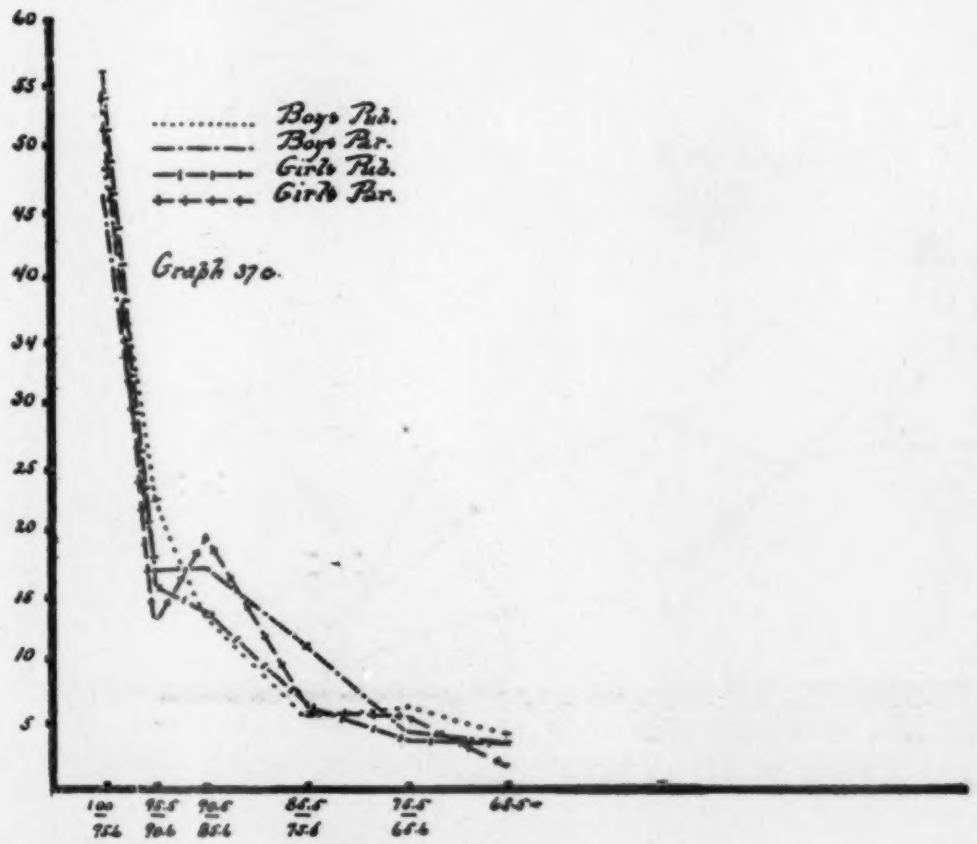
MEMORY. 7 PLACE DIGITS. 14 YEARS.



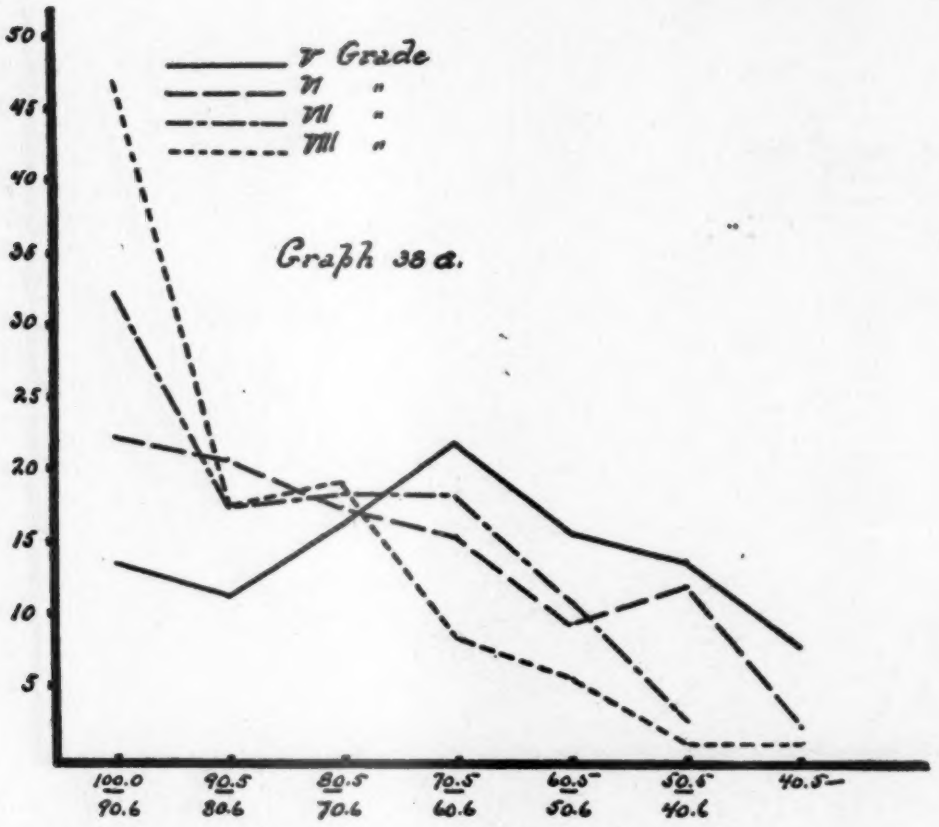
MEMORY. 7 PLACE DIGITS. 15 YEARS. BOYS.



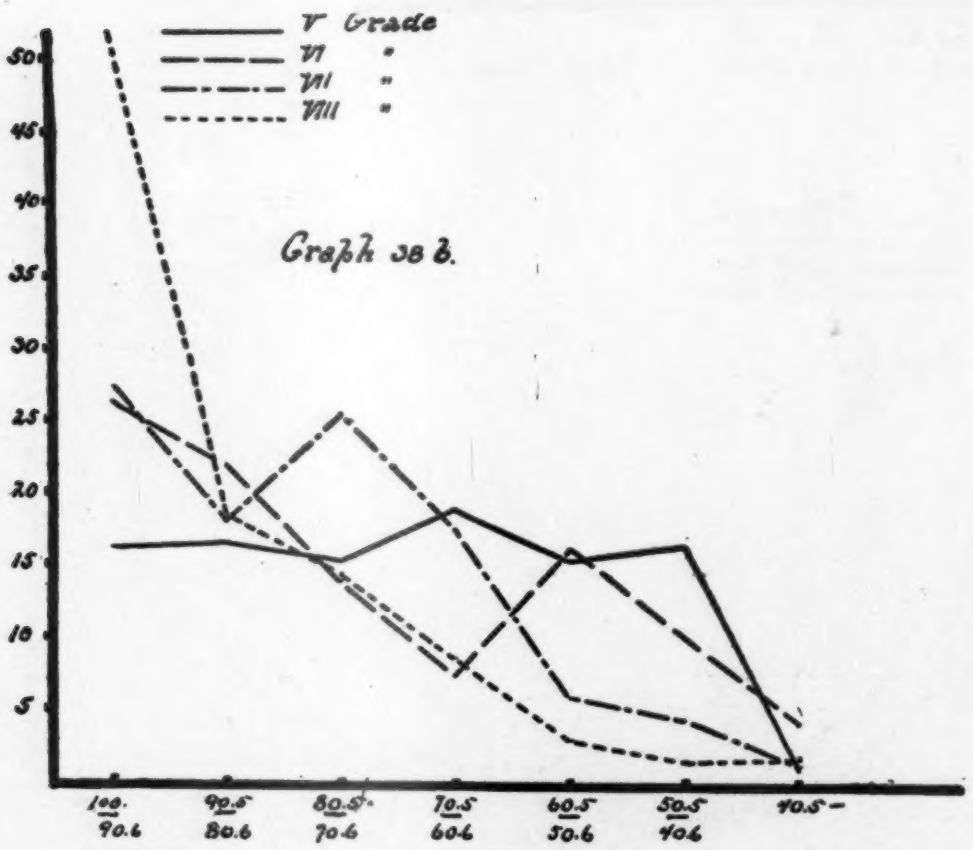
MEMORY. 7 PLACE DIGITS. 15 YEARS. GIRLS



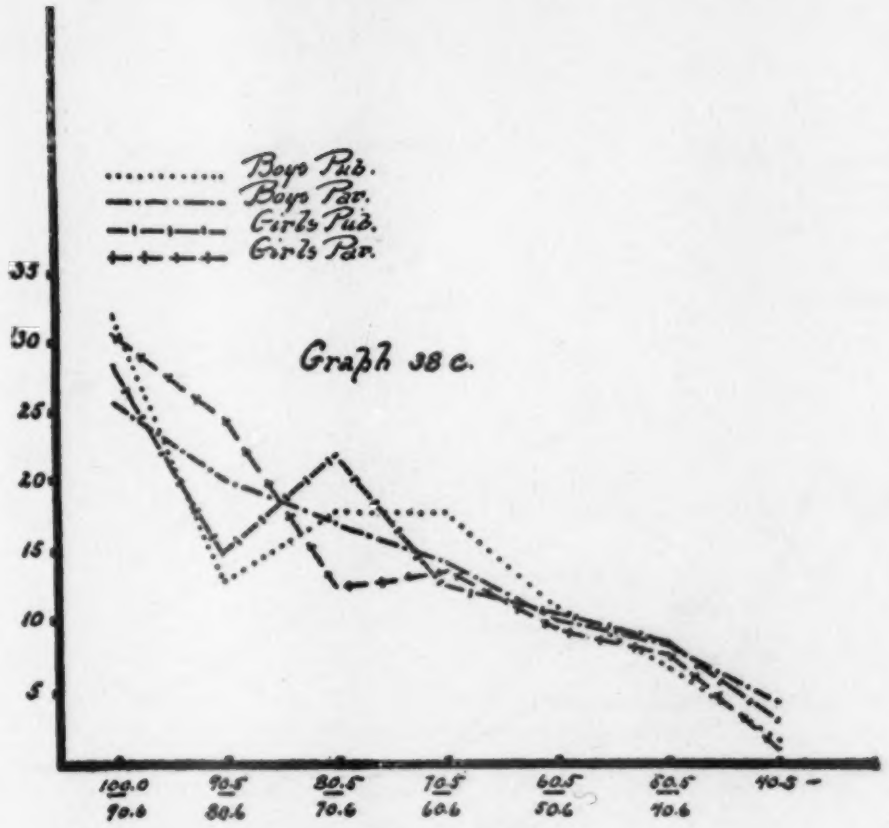
MEMORY. 7 PLACE DIGITS. 15 YEARS. .



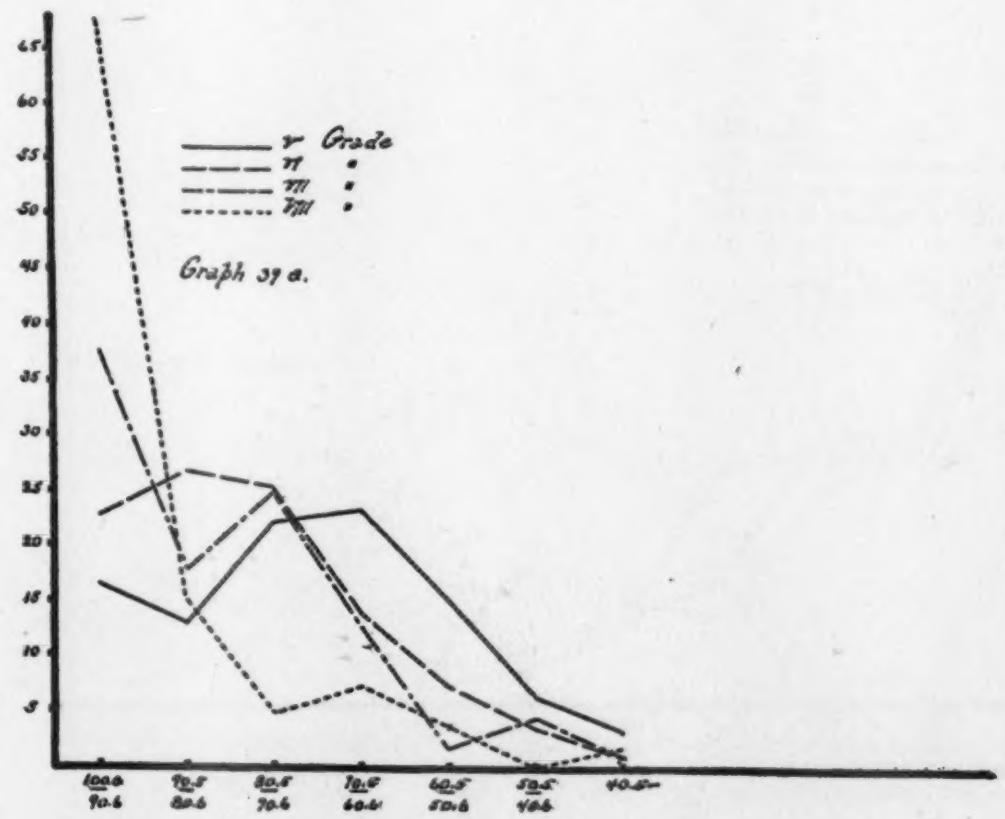
MEMORY. 8 PLACE DIGITS. 14 YEARS. BOYS.



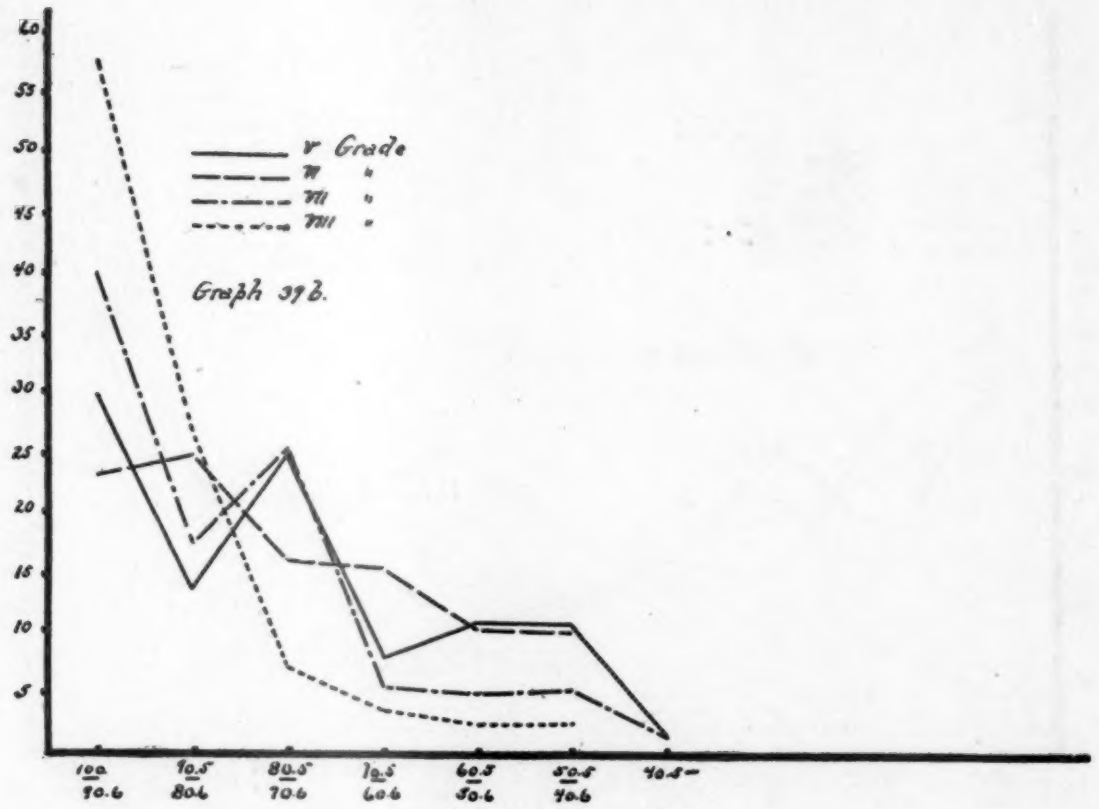
MEMORY. 8 PLACE DIGITS. 14 YEARS. GIRLS.



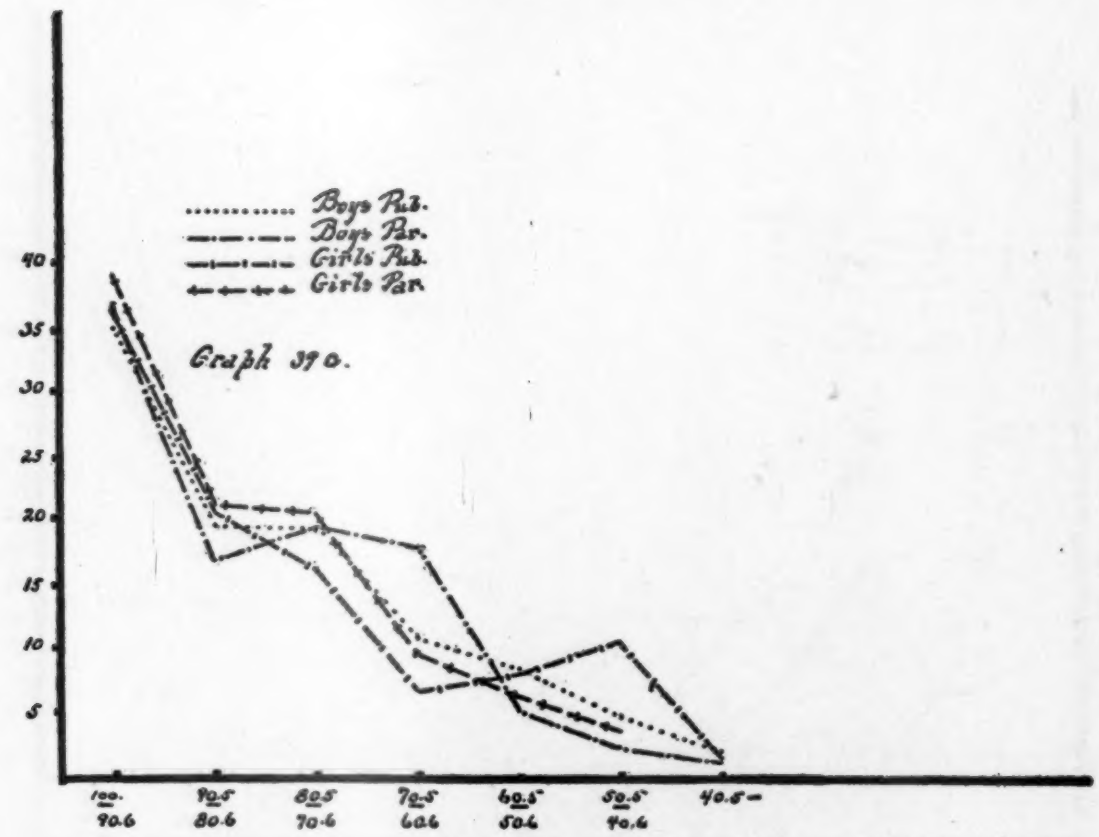
MEMORY. 8 PLACE DIGITS. 14 YEARS.



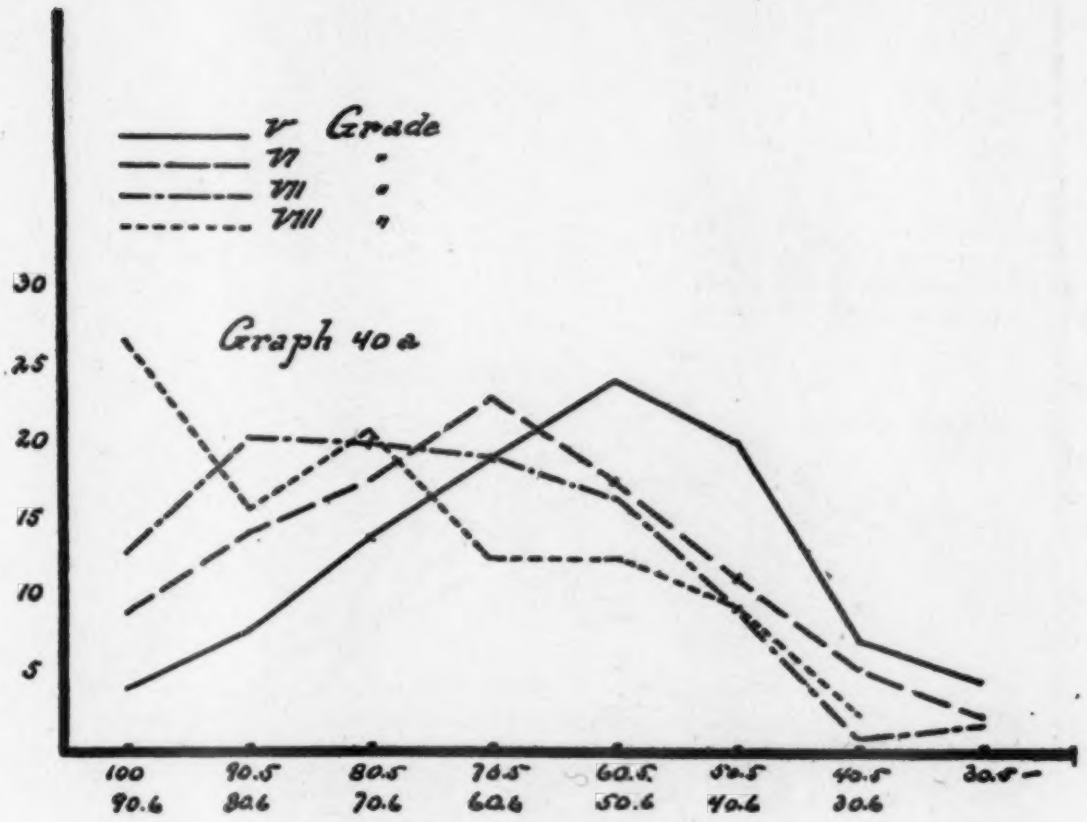
MEMORY. 8 PLACE DIGITS. 15 YEARS. BOYS.



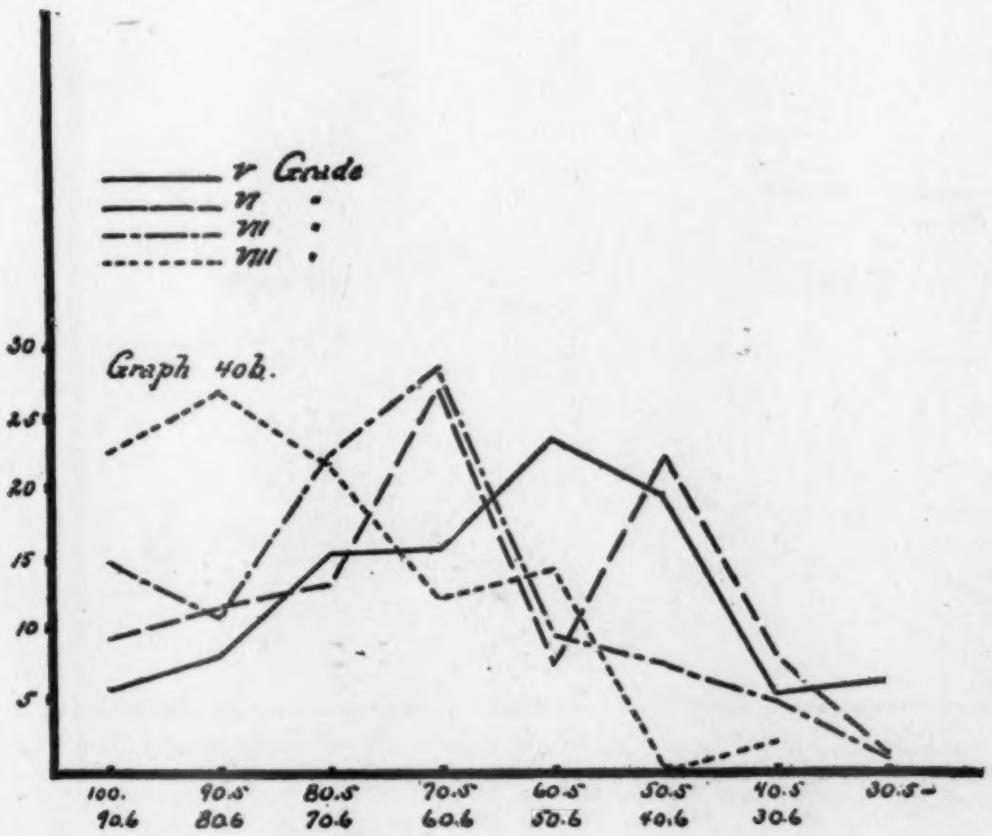
MEMORY. 8 PLACE DIGITS. 15 YEARS. GIRLS.



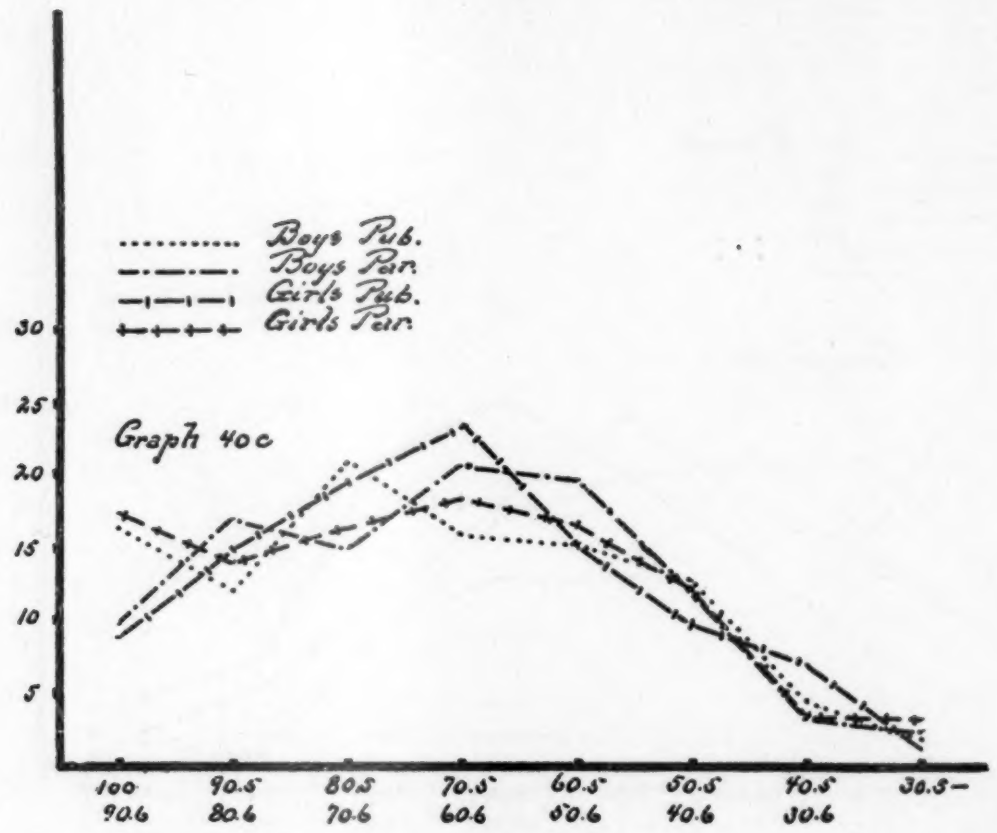
MEMORY. 8 PLACE DIGITS. 15 YEARS.



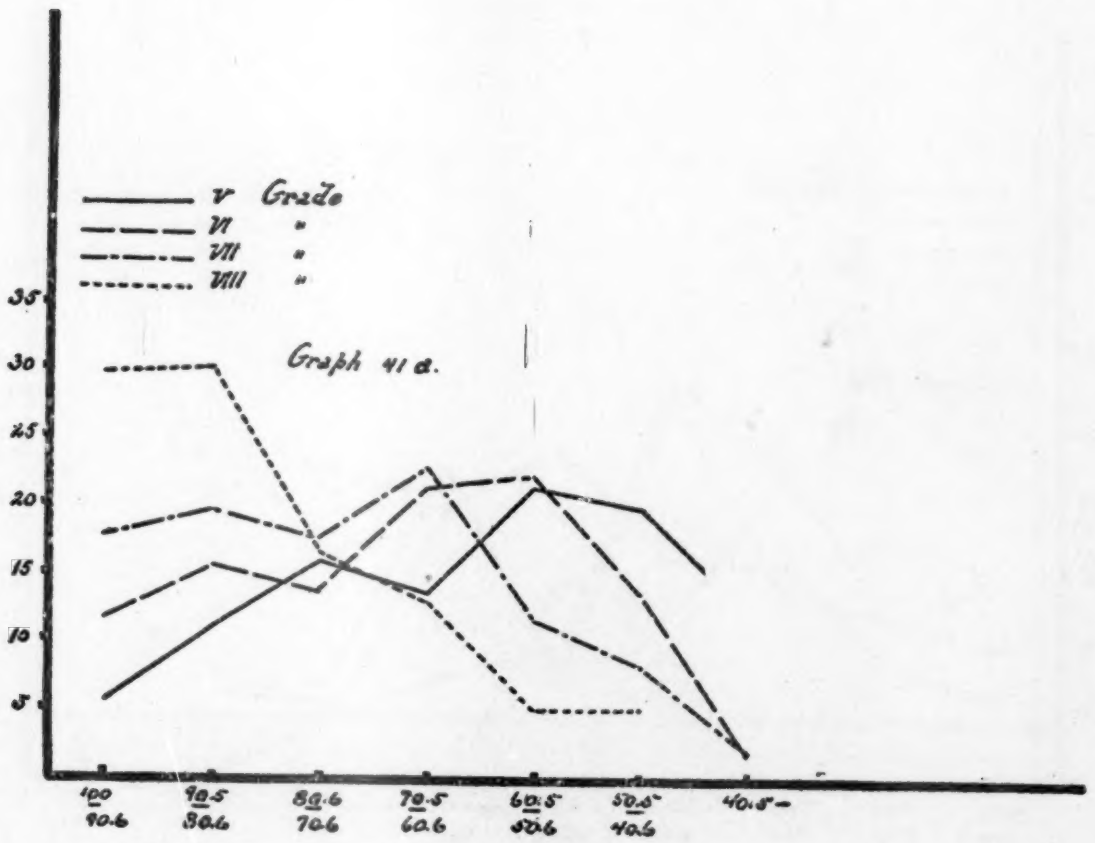
MEMORY. 9 PLACE DIGITS. 14 YEARS. BOYS.



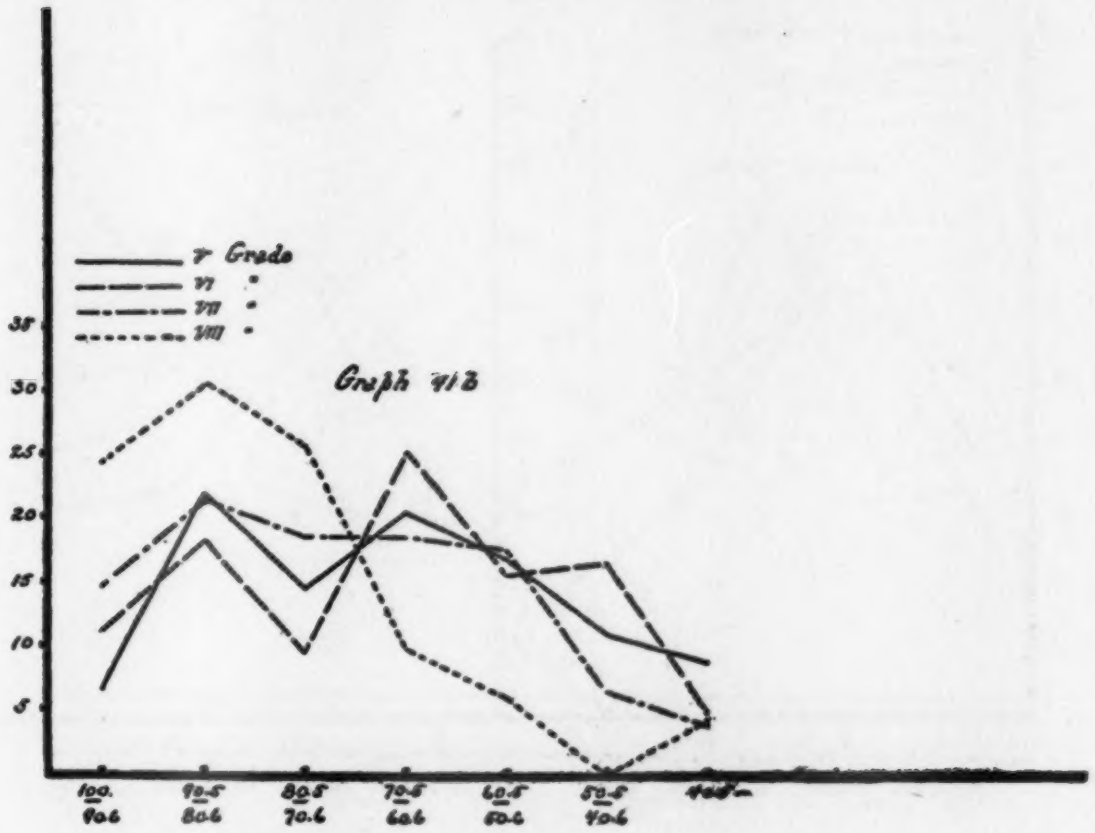
MEMORY. 9 PLACE DIGITS. 14 YEARS. GIRLS.



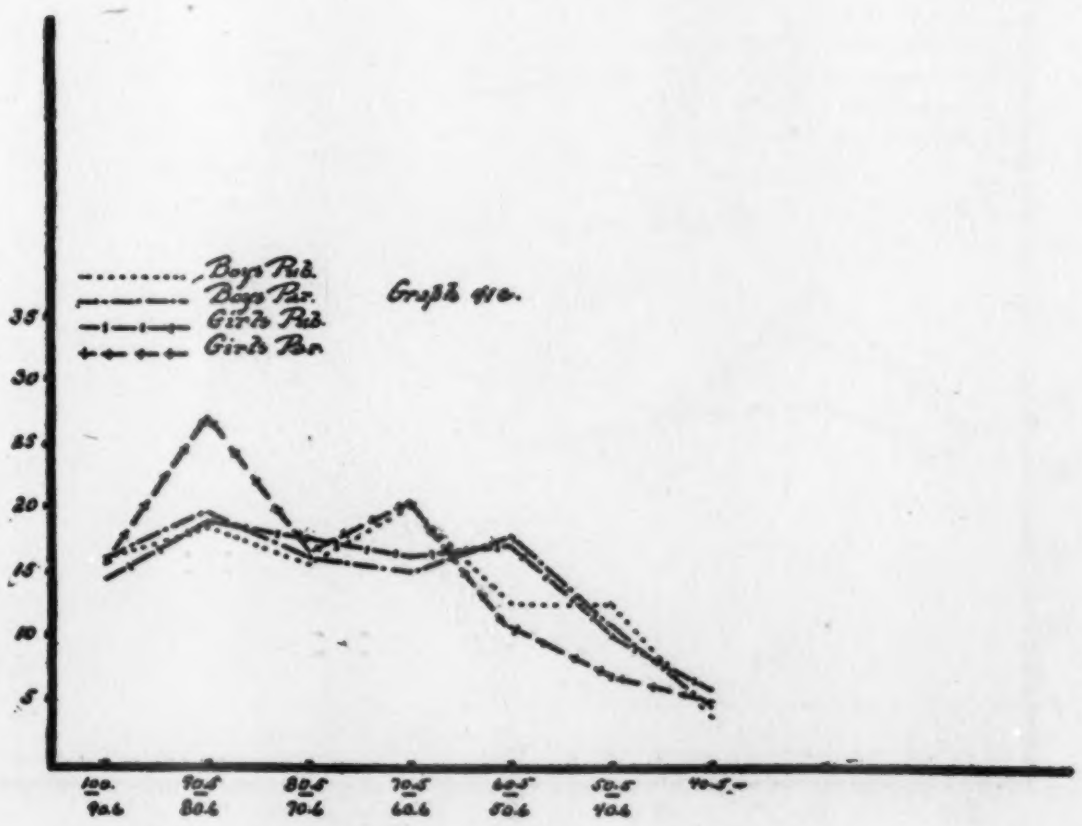
MEMORY. 9 PLACE DIGITS. 14 YEARS.



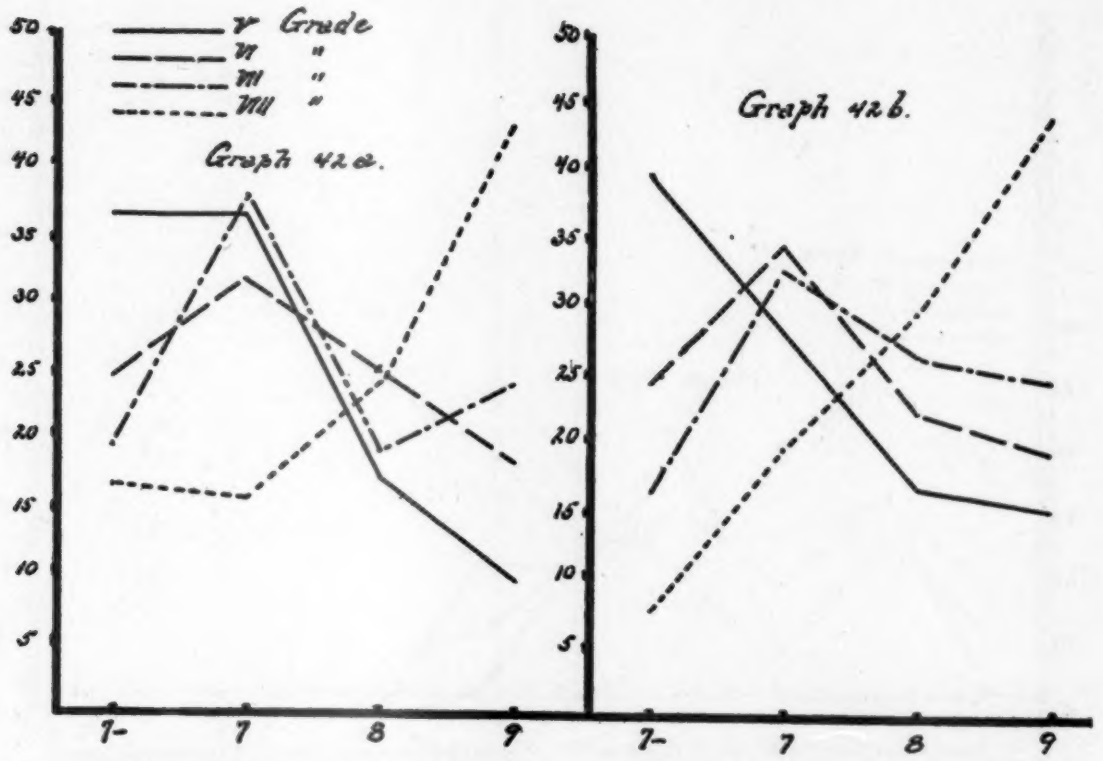
MEMORY. 9 PLACE DIGITS. 15 YEARS. BOYS.



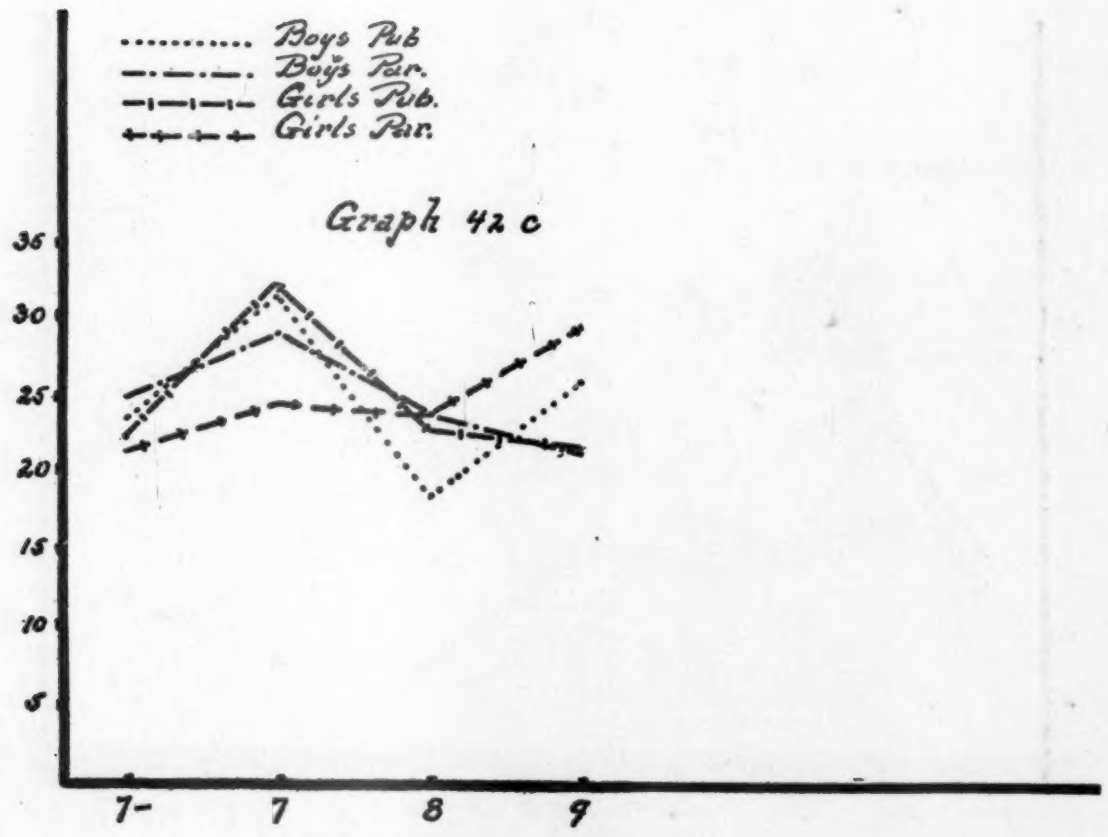
MEMORY. 9 PLACE DIGITS. 15 YEARS. GIRLS.



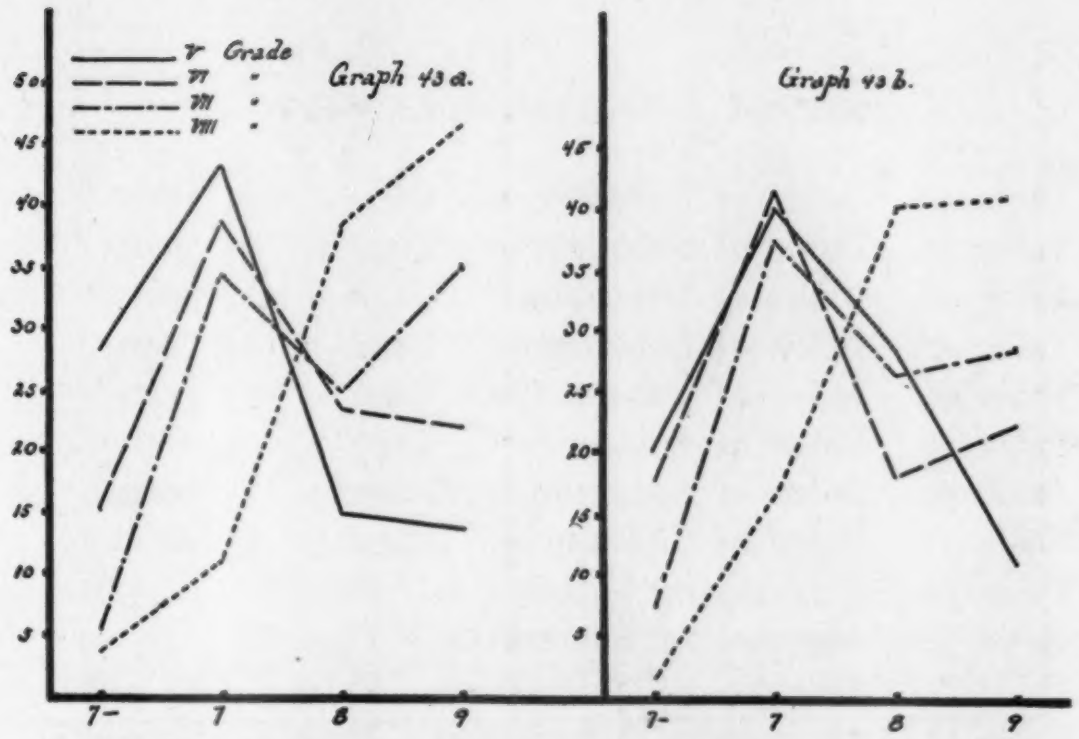
MEMORY. 9 PLACE DIGITS. 15 YEARS.



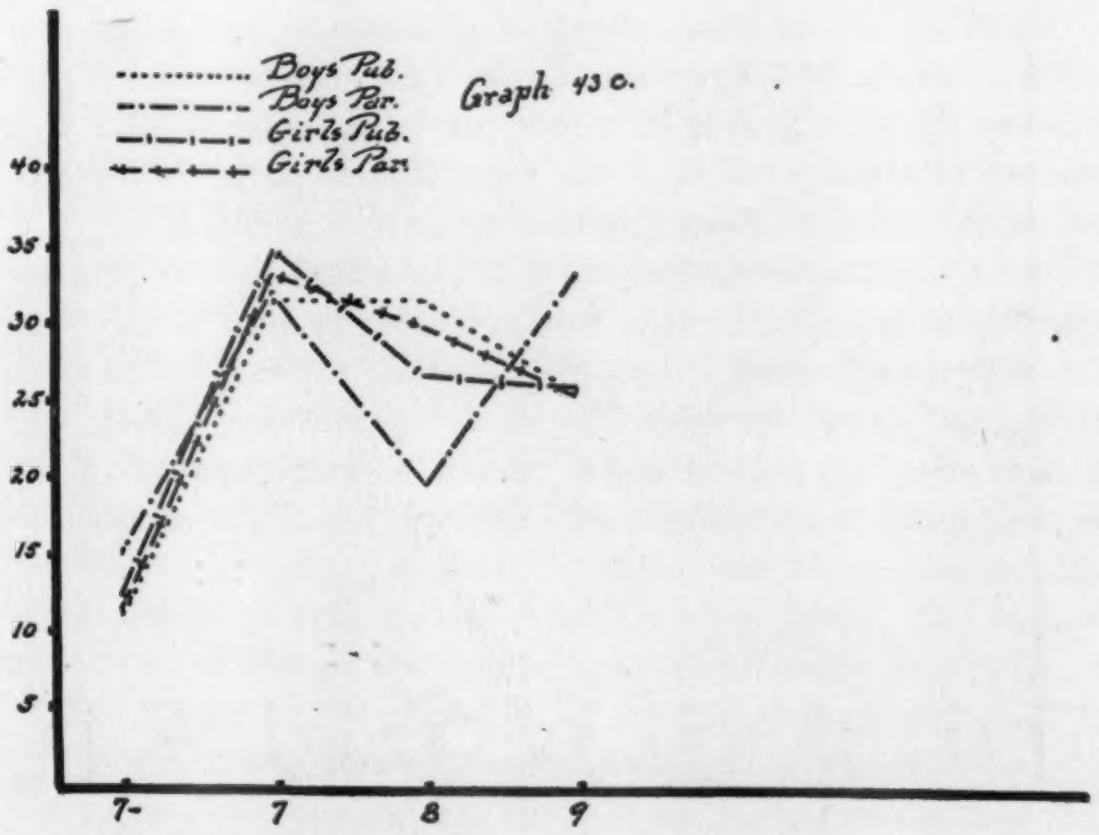
MEMORY SPAN. 14 YEARS. BOYS. MEMORY SPAN. 14 YEARS. GIRLS.



MEMORY SPAN. 14 YEARS.



MEMORY SPAN. 15 YEARS. BOYS. MEMORY SPAN. 15 YEARS. GIRLS.



MEMORY SPAN. 15 YEARS.

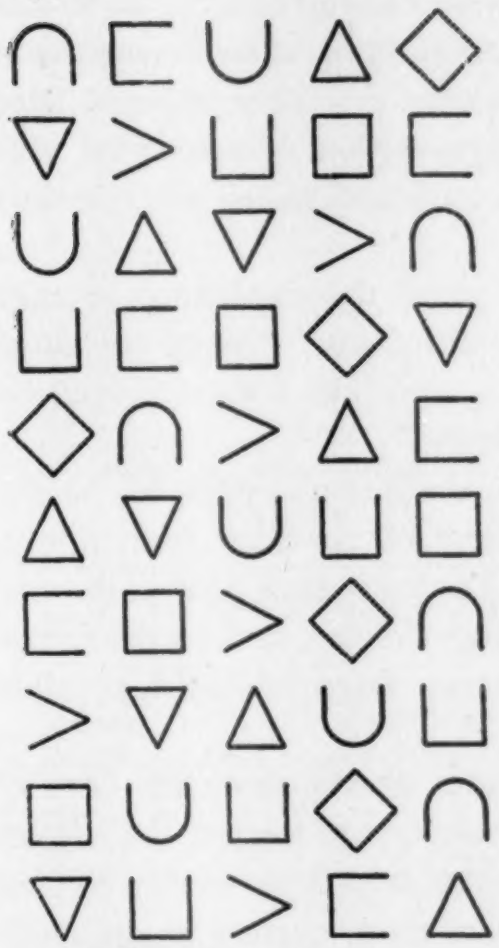
Section XII—Substitution Test

Table 44. Index of Substitution. Page 1. 14 years.
Table 45. Index of Substitution. Page 2. 14 years
Table 46. Index of Substitution. Page 3. 14 years
Table 47. Index of Substitution. Page 4. 14 years.
Table 48. Index of Substitution. Page 1. 15 years.
Table 49. Index of Substitution. Page 2. 15 years.
Table 50. Index of Substitution. Page 3. 15 years.
Table 51. Index of Substitution. Page 4. 15 years.
Table 52. Accuracy of Substitution. Page 1. 14 years.
Table 53. Accuracy of Substitution. Page 2. 14 years.
Table 54. Accuracy of Substitution. Page 3. 14 years.
Table 55. Accuracy of Substitution. Page 4. 14 years.
Table 56. Accuracy of Substitution. Page 1. 15 years.
Table 57. Accuracy of Substitution. Page 2. 15 years.
Table 58. Accuracy of Substitution. Page 3. 15 years.
Table 59. Accuracy of Substitution. Page 4. 15 years.

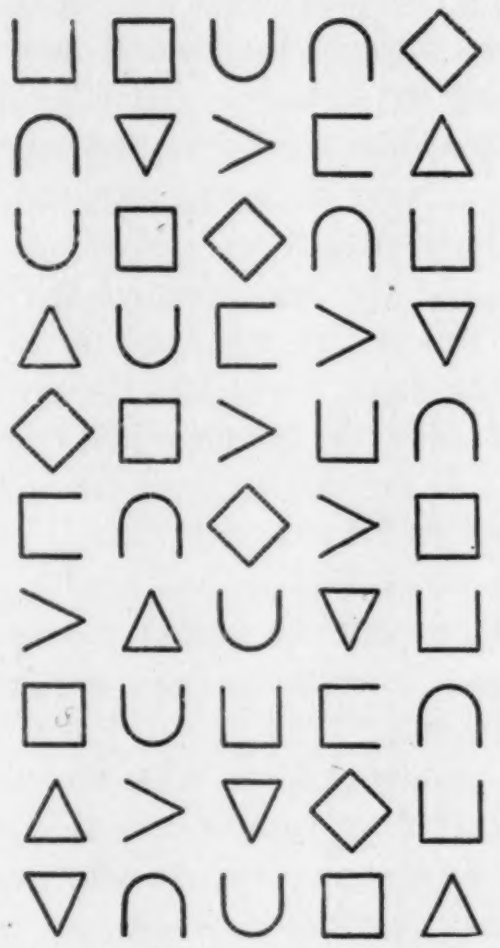
Materials—Four blank pages of geometrical figures of nine different kinds, fifty figures on a page (see illustration). A card bearing the nine figures in a row, with the digits from 1 to 9 printed in the figures in order (see illustration). A piece of cardboard the size of one page of figures. A stop-watch.

The set of blanks used in this test was devised by the Director for this series. Each page was arranged in such a way that every figure appeared as nearly as possible the same number of times, and no line contained the same figure twice. There was a number of keys, involving a variety of arrangements of the figures, so that each represented a different set of associations.

[1]



[2]



(Reduced in size.)

Method of administering the test—The experimenter laid the first page of figures before the child on the table, set the card up where it could be easily seen, and gave instructions as follows:

"You see this page of figures. Now on this card I have the same figures, but each figure has a number in it. What I want you to do is to write in each figure on this page, the number that you see in the same figure on that card. For instance, what figure would you put in here? (experimenter points to one of the figures which might easily be confused with another one—the figure ▽ or **U** . If the child makes the wrong answer, the experimenter points out the error), and in here? (the experimenter takes one of the unique figures). I want you to begin here at the top of the page, and fill the figures in in rows, just as you come to them. As you finish each row, I will cover it up with this piece of cardboard, this way. Now begin, and see how fast you can get the whole page done."

The stop-watch was started as soon as the child began to look on the card for his first number, and stopped as he finished writing the last one. After the time for the first page was recorded, the child was given the second page, with the instruction:

"Now fill in this page the same way, and see if you can do it faster this time."

At the beginning of the third page, the experimenter said: "Fill in this page, and try to do it still faster. When you finish this page, I will take the card away, and then I want you to try to fill in the last page just from memory."

If the child noticed errors before the line was covered, he was allowed to correct them. The object of covering each line as soon as the child had filled it in, was to make sure that on the first three pages he worked constantly from the key, and on the fourth page constantly from memory—never from his own previous records.

Some children who made no errors on the first few lines of page four, became uncertain and made errors toward the bottom of the page. Others who were uncertain at first, seemed to gain confidence as they went on, and were more correct in the latter part of the page than in the beginning.

Method of dealing with results—The time and accuracy were recorded for each page separately. Since there were just fifty figures on a page, each error or omission meant two per cent off from one hundred. The two measures were then combined into an index, which was time divided by accuracy, or the estimated time of perfection. For the first three pages, which were done with the key, the index seems a fair measure. It was doubtless true that those who made errors, could have done those pages perfectly if they had taken a somewhat longer time. But with regard to the fourth page, the index is a less understandable quantity. It is not at all a safe assumption that those who made errors on the memory page, could have done it correctly if they had taken more time. The index in this case serves only the purpose of providing a rough, and somewhat arbitrary method of assigning a value to the test in which both factors play a part.

To assign a value to the performance of any individual in

this test, all four pages must be taken into consideration. We must know not only how well he did on the fourth page, but how much time he had put into the learning process of the first three pages. The most significant fact about the test seems to be the rate of the first three pages, that is two individuals may have arrived at the same degree of perfection on the fourth page, but one of them may have taken twice the time of the other to arrive there.

RESULTS

	Page I		Page II		Page III		Page IV	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
25 perc.	147.0	142.0	115.7	108.7	97.4	94.0	89.6	88.5
50 perc.	172.7	162.6	133.2	130.4	115.9	112.7	111.2	112.6
75 perc.	200.9	185.6	157.6	154.0	138.4	134.8	148.3	150.5
Q	26.9	21.8	20.9	22.6	20.5	20.4	29.3	31.0
Limits—								
Lower	71.0	83.3	68.5	68.0	59.4	59.8	53.0	52.3
Upper	400.0	419.5	378.0	298.4	276.4	242.9	1257.6	525.4*

Substitution. Index in seconds. 14 years. Percentiles and limits
* (One case of complete failure (6% accuracy) gave an index of 60,000.)

	Page I		Page II		Page III		Page IV	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
25 perc.	137.3	130.4	104.6	103.6	92.0	91.9	84.4	85.3
50 perc.	157.3	148.6	123.7	119.0	110.7	108.7	104.9	103.9
75 perc.	179.0	171.6	145.7	138.1	133.4	128.7	145.7	139.3
Q	20.8	20.6	20.5	17.2	20.7	18.4	30.6	27.0
Limits—								
Lower	82.2	98.4	55.0	67.4	54.0	59.2	52.6	50.6
Upper	286.6	307.8	241.3	295.1	355.5	248.6	906.5	19,875

Substitution. Index in seconds. 15 years. Percentiles and limits

	Page I		Page II		Page III		Page IV	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
25 perc.	89.3	90.2	94.7	94.3	96.1	96.1	85.9	84.7
50 perc.	94.8	94.6	97.1	97.3	98.1	98.1	96.4	95.9
75 perc.	97.3	97.4	98.7	98.8	99.1	99.1	98.7	98.6
Q	4.0	3.6	2.0	2.2	1.5	1.5	6.4	6.9
Limits—								
Lower	50.0	70.0	56.0	66.0	66	78	28	24*
Upper	100	100	100	100	100	100	100	100

Substitution. Accuracy in per cents. 14 years. Percentiles and limits
* One case of complete failure had an accuracy of 6%

	Page I		Page II		Page III		Page IV	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls
25 perc.	95.0	96.2	96.6	96.6	96.7	96.8	88.5	89.1
50 perc.	97.4	98.8	98.4	98.3	98.4	98.4	96.9	97.2
75 perc.	98.8	99.0	99.2	99.1	99.2	99.2	98.8	98.8
Q	1.9	1.4	1.3	1.2	1.2	1.2	5.1	4.8
Limits—								
Lower	70	64	70	82	64	82	16	8
Upper	100	100	100	100	100	100	100	100

Substitution. Accuracy in per cents. 15 years. Percentiles and limits

Correlation with School Grade.

Graph 44a—Substitution Index. Page 1. Boys, 14 years.
Graph 44b—Substitution Index. Page 1. Girls, 14 years.
Graph 45a—Substitution Index. Page 2. Boys, 14 years.
Graph 45b—Substitution Index. Page 2. Girls, 14 years.
Graph 46a—Substitution Index. Page 3. Boys, 14 years.
Graph 46b—Substitution Index. Page 3. Girls, 14 years.
Graph 47a—Substitution Index. Page 4. Boys, 14 years.
Graph 47b—Substitution Index. Page 4. Girls, 14 years.
Graph 48a—Substitution Index. Page 1. Boys, 15 years.
Graph 48b—Substitution Index. Page 1. Girls, 15 years.
Graph 49a—Substitution Index. Page 2. Boys, 15 years.

Graph 49b—Substitution Index. Page 2. Girls, 15 years.
Graph 50a—Substitution Index. Page 3. Boys, 15 years.
Graph 50b—Substitution Index. Page 3. Girls, 15 years.
Graph 51a—Substitution Index. Page 4. Boys, 15 years.
Graph 51b—Substitution Index. Page 4. Girls, 15 years.

The graphs for the index of the substitution test show a positive correlation with school grade for all four pages of the test, for both sexes, and at both ages. The only irregularity to be found is in the graphs for the boys at fifteen years, where the eighth grade drops down to, or below, the seventh, except on the first page.

The form of the graphs for the four pages, while retaining the grade correlation, changes in an interesting way. From the first page to the third, the distribution of the curve decreases. That is, with practice, the individual differences tend to decrease. On the fourth page, however, the one which measures the perfection of learning, the curve becomes even more extended for all grades than it was on the first practice page. In other words, the fourth page shows larger individual differences than any other, but they occur in all the grades. The grade correlation then, while it is retained on the fourth page, is less marked than it was on the practice pages. Regarding the fourth page as the measure of accomplishment, we can sum the matter up in this way—the children in the upper grades reach a somewhat higher plane of performance in the test than those in the lower grades, but it is most striking that they reach it in a much shorter time than those in the lower grades. Stated in terms of efficiency of learning, then, the children in the upper grades have a decided advantage, since they reach this somewhat higher plane of accomplishment in a much shorter time.

In order to know what part the correlative factors of time and accuracy play in this test, graphs were also drawn for accuracy alone, though they are not published. The result showed that there is a positive grade correlation of accuracy throughout the practice pages for both sexes and both ages, though it is not so marked, nor quite so consistent as in the case of the index. The

superior rapidity of the upper grade children is a larger element than their superior accuracy.

On the fourth, or memory page, the boys—at both ages, show a positive correlation of school grade with accuracy, but the girls show no correlation. In the final performance, therefore, the upper grade boys derive their advantage partly from superior speed, and partly from greater accuracy while the upper grade girls get their superiority entirely through speed.

Comparisons of Sex and School.

Graph 44c—Substitution Index. Page 1. 14 years.
Graph 45c—Substitution Index. Page 2. 14 years.
Graph 46c—Substitution Index. Page 3. 14 years.
Graph 47c—Substitution Index. Page 4. 14 years.
Graph 48c—Substitution Index. Page 1. 15 years.
Graph 49c—Substitution Index. Page 2. 15 years.
Graph 50c—Substitution Index. Page 3. 15 years.
Graph 51c—Substitution Index. Page 4. 15 years.

Sex—Both the percentiles and the graphs for the index of the substitution test for the three practice pages, show the girls to be a little superior to the boys. The difference is about the same in amount, both years. With regard to accuracy, the sex differences are so small, and so inconsistent in the various measures of the first three pages that they cannot be regarded as of any significance. The superiority of the girls, then, lies in their greater speed. On the fourth page, there is no sex difference in the index at fourteen, but at fifteen the girls are superior. With regard to accuracy, the boys are a bit better on the fourth page at fourteen, but at fifteen, they are a little inferior.

The sex difference may be summed up as follows:

At fourteen, there is no difference of sex in the performance of the fourth page, measured by the index. In terms of efficiency, the sexes are the same. They have reached this common standard, however, by different methods. The girls did both their practice pages, and the memory page faster than the boys. The boys were as accurate as the girls on these practice pages, and more accurate on the memory page. At fifteen years, the girls have a small advantage in both speed and accuracy. Their practice pages are

performed as accurately as the boys, and at the same time faster. On the memory page, the girls are a little superior both in accuracy and in index. There is a superiority in efficiency on the part of the girls, then both times. At fourteen, they reach as good a result, more rapidly than the boys. At fifteen, they reach a better result, more rapidly than the boys.

School—For the three practice pages, the index of the substitution test is better in the public school group than in the parochial at both ages. The accuracy is also superior among the public school-children for the first two pages, though on the third page the parochial have caught up with the public group. On the fourth, or memory page, at fourteen years, there is no distinction of school in the graphs, either for index or for accuracy. At fourteen, therefore, the public school children stand no better than the parochial group in the final measure of the test of learning. Their advantage consists in having accomplished the feat in a shorter time, and with fewer errors. At fifteen, the graphs, both for index and for accuracy, show an undoubted superiority of the public school group on the fourth page also. At that age, then, the public school group not only did their learning more rapidly, and with fewer mistakes in the process, but did it better measured by the final outcome also.

Age—The graphs are better throughout for the fifteen-year group than for the fourteen. The improvement in accuracy is particularly noticeable. But since the same blanks were used both years, some of the improvement is doubtless due to familiarity with the geometrical forms. To be sure the key used the second time, was different in every case, so that a completely new set of associations had to be formed the second time. But many of the errors in the first test arose from failure to distinguish between the similar forms of the blank, a sort of error which a general familiarity with the blank would help to reduce.

Each child was asked the second year whether he remembered the blank, and whether he knew what he had done with it the previous year. Although no numerical summary of the answers has been made, the general trend of them can be stated. Most of the children remembered having seen the blank, and having done

something with it. The majority did not remember the test well enough to be sure that what they had done before was to put numbers into the forms, and it was a very rare child who remembered any single detail as to which number belonged in any given form. There was no reason to think, therefore, that definite memories of the set of associations from the year before played the part of an element of confusion in the learning of the new set of associations, but a general memory of the page may have led to a more accurate discrimination of the similar forms.

It seems worth while to mention in passing, an observation made a number of times, though its interpretation is doubtful. There were cases in which the child denied any detailed memory of the test of the previous year, and yet on the fourth, or memory page, made the error of using some associations of the year before instead of those of the key he had just been learning. These cases seem to furnish interesting instances of so-called unconscious memories or sub-conscious associations. The difficulty is that one can not be absolutely certain of the truthfulness of the child's denial of a conscious memory of the previous test. One can even see a possible motive for untruthfulness, in that the child may have thought that if he denied a memory of the previous test, he would be given the same key again. Although this may have happened in these few cases, it is quite certain that there was no general prevarication.

TABLE 44
Index of Substitution. Page 1. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Seconds	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100.0—	0		0		0		0				0		0		0		0			
	100.1 - 120.0	2	2.8	1	1.8	1	2.9	0				2	5.3	2	3.8	2	6.2	2		7.7	
	120.1 - 140.0	9	12.7	6	10.9	8	22.8	8		40.		1	2.6	10	19.2	3	9.4	11	1	46.1	
	140.1 - 160.0	10	14.0	14	25.4	10	29.4	4	1	25.		9	23.7	9	17.3	13	40.6	3		11.5	
	160.1 - 180.0	7	9.8	13	23.6	7	20.6	5		25.		13	34.2	12	23.1	6	18.7	5	1	23.1	
	180.1 - 200.0	17	23.9	6	10.9	2	5.7	2		10.		7	18.4	12	23.1	4	12.5	2		7.7	
	200.1 - 220.0	13	18.3	7	12.7	6	17.6	0		0.		3	7.9	3	5.8	1	3.1	1		3.8	
	220.1 - 240.0	4	5.6	2	3.6	0	0.	0		0.		0	0.	2	3.8	2	6.1	0		0.	
	240.1 - 260.0	3	4.2	3	5.4	0	0.	0		0.		2	5.3	2	3.8	0	0.	0		0.	
	260.1 - 280.0	4	5.6	1	1.8	0	0.	0		0.		0	0.	0	0.	0	0.	0		0.	
	280.1 - 300.0	1	1.4	0	0.0	0	0.	0		0.		1	2.6	0	0.	1	3.1	0		0.	
	300.1+	1	1.4	2	3.6	0	0.	0		0.		0	0.	0	0.	0	0.	0		0.	
	Total	71		55		34		19	1			38		52		32		24	2		
	Omitted	15		13		9		3	1			5		7		11		0	1		
Parochial School	100.0—	0		1	2.1	0		1		2.8		1	4.3	0		0		0			
	100.1 120.0	0		0	0.	4	8.7	1		2.8		0	0.	1	2.5	3	6.1	4		12.5	
	120.1 - 140.0	2	6.1	5	10.6	6	13.0	5	2	20.0		3	13.0	2	5.0	9	18.4	7	2	28.1	
	140.1 - 160.0	5	15.1	9	19.1	8	17.4	8		22.8		3	13.0	8	20.0	17	34.7	8	1	28.1	
	160.1 - 180.0	6	18.1	10	21.3	10	21.7	5		14.3		4	17.4	10	25.0	12	24.5	7		21.9	
	180.1 - 200.0	8	24.2	6	12.8	12	25.1	6	1	20.0		4	17.4	8	20.0	3	6.1	3		9.4	
	200.1 - 220.0	5	15.1	9	19.1	4	8.7	3		8.6		3	13.0	4	10.0	0	0.	0		0.	
	220.1 - 240.0	3	9.1	4	8.5	1	2.2	2		5.7		3	13.0	2	5.0	2	4.1	0		0.	
	240.1 - 260.0	2	6.1	3	6.4	0	0.	1		2.8		0	0.	3	7.5	3	6.1	0		0.	
	260.1 - 280.0	0	0.	0	0.	0	0.	0		0.		0	0.	0	0.	0	0.	0		0.	
	280.1 - 300.0	0	0.	0	0.	0	0.	0		0.		1	4.3	1	2.5	0	0.	0		0.	
	300.1+	2	6.1	0	0.	1	2.2	0		0.		1	4.3	1	2.5	0	0.	0		0.	
	Total	33		47		46		32	3			23		40		49		29	3		
	Omitted	5		12		19		5	0			3		3		6		2	0		

UNIVERSITY OF MICHIGAN LIBRARIES

TABLE 45
Index of Substitution. Page 2. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Seconds	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	80.0—	3	4.2	0		3	8.8	2		9.5		3	7.9	6	11.1	1	3.2	5		19.2	
	80.1 - 100.0	12	16.9	15	27.8	6	17.6	6		28.6		6	15.8	12	22.2	8	25.8	7		26.9	
	100.1 - 120.0	18	25.3	19	35.2	11	32.3	4	1	23.8		8	21.0	17	31.5	14	45.2	6	1	26.9	
	120.1 - 140.0	17	23.9	9	16.7	10	29.4	3	1	19.0		9	23.7	12	22.2	7	22.6	5		19.2	
	140.1 - 160.0	11	15.5	4	7.4	3	8.8	3		14.3		7	18.4	4	7.4	0		0	1	3.8	
	160.1 - 180.0	5	7.0	3	5.6	1	2.9	1		4.8		5	13.2	2	3.7	1	3.2	1		3.8	
	180.1 - 200.0	4	5.6	2	3.7	0		0				0		0		0					
	200.1 - 220.0	1	1.4	1	1.8	0		0				0		0		0					
	220.1+			1	1.8	0		0				0		1	1.9	0					
	Total	71		54		34		19	2			38		54		31		24	2		
	Omitted	15		14		9		3	0			5		5		12		0	1		
Parochial School	80.0—	3	9.4	3	6.4	4	8.5	5	1	18.2		1	4.8	2	5.0	4	8.2	5	1	18.7	
	80.1 - 100.0	1	3.1	7	14.9	15	31.9	8		24.2		3	14.3	6	15.0	11	22.4	10	1	34.4	
	100.1 - 120.0	6	18.7	14	29.8	13	27.7	9		27.3		7	33.2	9	22.5	17	34.7	5		15.6	
	120.1 - 140.0	8	25.0	10	21.3	9	19.1	3	1	12.1		4	19.0	4	10.0	10	20.4	5	1	18.7	
	140.1 - 160.0	5	15.6	8	17.0	2	4.3	2		6.1		4	19.0	16	40.0	1	2.0	3		9.4	
	160.1 180.0	6	18.8	5	10.6	3	6.4	2		6.1		1	4.8	1	2.5	5	10.2	1		3.1	
	180.1 - 200.0	0		0		1	2.1	1		3.0		0		0		1	2.0	0			
	200.1 - 220.0	1	3.1	0		0		1		3.0		0		0		0		0			
	220.1+	2	6.3	0		0		0				1	4.8	2	5.0	0		0			
	Total	32		47		47		31	2			21		40		49		29	3		
	Omitted	6		12		18		6	1			5		3		6		2	0		

TABLE 46
Index of Substitution. Page 3. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
PUBLIC SCHOOL	Seconds	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
	80.0—	0		0		0		2		9.5		1	2.6	1	1.8	0		1		3.8	
	80.1 - 100.0	4	5.5	3	5.4	7	20.6	1		4.8		1	2.6	7	12.7	2	6.2	6		23.1	
	100.1 - 120.0	10	13.7	9	16.4	5	14.7	7		33.2		9	23.7	14	25.4	11	34.4	7		26.9	
	120.1 - 140.0	19	26.0	25	45.4	12	35.3	8	1	42.8		10	26.3	10	18.2	11	34.4	5	1	23.1	
	140.1 - 160.0	12	16.4	7	12.7	7	20.6	0	1	4.8		6	15.8	15	27.3	4	12.5	3	1	15.4	
	160.1 - 180.0	15	20.5	6	10.9	1	2.9	0				7	18.4	6	10.9	3	9.4	1		3.8	
	180.1 - 200.0	8	11.0	2	3.6	2	5.9	1		4.8		1	2.6	1	1.8	1	3.1	1		3.8	
	200.1 - 220.0	4	5.5	1	1.8	0		0				3	7.9	0	0.	0		0			
	220.1+	1	1.4	2	3.6	0		0				0		1	1.8	0		0			
	Total	73		55		34		19	2			38		55		32		24	2		
	Omitted	13		13		9		3	0			5		4		11		0	1		
PAROCHIAL SCHOOL	800—	0		0		2	4.2	1	1	5.5		0		0		0		1		3.1	
	80.1 - 100.0	2	6.1	3	6.2	5	10.6	4		11.1		4	17.4	3	7.5	7	14.3	9	1	31.2	
	100.1 - 120.0	3	9.1	8	16.7	14	29.8	9	1	27.7		2	8.7	5	12.5	14	28.6	5	1	18.7	
	120.1 - 140.0	8	24.2	16	33.3	10	21.3	11		30.5		4	17.4	8	20.0	11	22.4	7	1	25.0	
	140.1 - 160.0	8	24.2	9	18.7	8	17.0	3	1	11.1		5	21.7	9	22.5	12	24.5	4		12.5	
	160.1 - 180.0	3	9.1	7	14.6	6	12.8	1		2.8		3	13.0	7	17.5	4	8.2	2		6.2	
	180.1 - 200.0	5	15.1	4	8.3	2	4.2	2		5.5		3	13.0	4	10.0	0	0.	1		3.1	
	200.1 - 220.0	2	6.1	1	2.1	0		0		0.		0	0.	0	0.	1	2.0	0			
	220.1+	2	6.1	0		0		2		5.5		2	8.7	4	10.0	0	0.	0			
	Total	33		48		47		33	3			23		40		49		29	3		
	Omitted	5		11		18		4	0			3		3		6		2	0		

UNIVERSITY OF MICHIGAN LIBRARIES

TABLE 47
Index of Substitution. Page 4. 14 years

School	Grade	Boys V		Boys VI		Boys VII		Boys VIII	Boys IX	Boys VIII and IX	Girls V		Girls VI		Girls VII		Girls VIII	Girls IX	Girls VIII and IX
	Seconds	No.	%	No.	%	No.	%	No.	No.	%	No.	%	No.	%	No.	%	No.	No.	%
Public School	60.0—	0		0		0		0			1	2.7	1	1.8	0		0		
	60.1 - 80.0	6	8.6	5	9.3	4	12.1	4		19.0	3	8.1	8	14.9	2	6.4	7		26.9
	80.1 - 100.0	14	20.0	19	35.2	8	24.2	6		28.6	7	18.9	12	22.2	9	29.0	7		26.9
	100.1 - 120.0	19	27.1	10	18.5	8	24.2	2	1	14.3	3	8.1	9	16.7	8	25.8	5		19.2
	120.1 - 140.0	6	8.6	7	13.0	4	12.1	3		14.3	5	13.5	9	16.7	4	12.9	1	1	7.7
	140.1 - 160.0	5	7.1	5	9.3	3	9.1	1		4.8	7	18.9	3	5.5	3	9.7	1	1	7.7
	160.1 - 180.0	5	7.1	1	1.8	2	6.1	1		4.8	3	8.1	4	7.4	2	6.4	0		
	180.1 - 200.0	3	4.3	1	1.8	0		1		4.8	1	2.7	2	3.7	1	3.2	0		
	200.1 - 220.0	3	4.3	2	3.7	1	3.0	0	1	4.8	2	5.4	1	1.8	1	3.2	1		3.8
	220.1 - 240.0	2	2.8	1	1.8	0		0		0.	0		0		0		0		
	240.1 - 260.0	2	2.8	0		2	6.1	0		0.	2	5.4	1	1.8	1	3.2	2		7.7
	260.1 - 280.0	2	2.8	1	1.8	0		0		0.	0		1	1.8	0		0		
	280.1+	3	4.3	2	3.7	1	3.0	1		4.8	3	8.1	3	5.5	0		0		
	Total	70		54		33		19	2		37		54		31		24	2	
	Omitted	16		14		10		3	0		6		5		12		0	1	
Parochial School	60.0—	0		0		0		1	1		0		0		0		0		
	60.1 - 80.0	2	6.4	4	8.3	12	26.1	5		20.6	1	4.3	3	7.7	7	14.3	8	1	28.1
	80.1 - 100.0	6	19.4	8	16.7	12	26.1	9	2	32.3	6	26.1	10	25.6	17	34.7	4		12.5
	100.1 - 120.0	2	6.4	15	31.2	11	23.9	4		11.8	5	21.7	8	20.5	7	14.3	4	1	15.6
	120.1 - 140.0	3	9.7	9	18.7	4	8.7	6		17.6	4	17.4	3	7.7	7	14.3	5		15.6
	140.1 - 160.0	4	12.9	6	12.5	1	2.2	1		2.9	1	4.3	6	15.4	3	6.1	4		12.5
	160.1 - 180.0	2	6.4	0		3	6.5	0			2	8.7	1	2.6	1	2.1	1		3.1
	180.1 - 200.0	0		5	10.4	1	2.2	0			1	4.3	0		3	6.1	1		3.1
	200.1 - 220.0	0		0		0		1		2.9	0		1	2.6	0		2		6.3
	220.1 - 240.0	1	3.2	1	2.1	1	2.2	1		2.9	1	4.3	1	2.6	2	4.1	0		
	240.1 - 260.0	4	12.9	0		0		0			0		0		1	2.0	0		
	260.1 - 280.0	1	3.2	0		1	2.2	0			0		0		1	2.0	0		
	280.1+	6	19.4	0		0		3		8.8	2	8.7	6	15.4	0		0	1	3.1
	Total	31		48		46		31	3		23		39		49		29	3	
	Omitted	7		11		19		6	0		3		4		6		2	0	

TABLE 48
Index of Substitution. Page 1. 15 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Seconds	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Parochial School	100.0—	0		0		1		1				0		0		0		2			
	100.1 - 120.0	2	2.5	4	6.8	5	14.3	3		16.7		0		4	7.5	2	5.6	4	1	33.3	
	120.1 - 140.0	15	19.0	11	18.6	11	26.2	6	1	29.2		11	31.4	14	26.4	17	47.2	5		23.8	
	140.1 - 160.0	18	22.8	23	39.0	12	28.6	8		33.3		9	25.7	14	26.4	8	22.2	4		19.0	
	160.1 - 180.0	24	30.4	12	20.3	9	21.4	1		4.2		8	22.9	12	22.6	5	13.9	3		14.3	
	180.1 - 200.0	11	13.9	2	3.4	2	4.8	2	1	12.5		3	8.6	2	3.8	2	5.6	2		9.5	
	200.1 - 220.0	5	6.3	1	1.7	2	4.8					3	8.6	4	7.5	1	2.8				
	220.1 - 240.0	2	2.5	3	5.1							0	0.0	3	5.7	1	2.8				
	240.1 - 260.0	0		1								1									
	260.1 - 280.0	1		2				1				0									
	280.1 - 300.0	1	2.5	0	5.1					4.2		0	2.9								
	Total	79		59		42		22	2			35		53		36		20	1		
	Omitted	1		3		1						1									
Public School	100.0—	0		0		1		1				0		0		0		0			
	100.1 - 120.0	1	3.0	1	1.9	4	8.2	5		18.7		1	4.2	1	2.7	6	12.	5	1	20.7	
	120.1 - 140.0	3	9.1	12	23.1	12	19.7	6		18.7		3	12.5	8	21.6	16	32.	9	2	37.9	
	140.0 - 160.0	10	30.3	4	7.7	17	27.9	6		18.7		9	37.5	9	24.3	12	24.	6		20.7	
	160.1 - 180.0	5	15.1	10	19.2	17	27.9	9		28.1		4	16.7	9	24.3	8	16.	4		13.8	
	180.1 - 200.0	6	18.2	13	25.0	6	9.8	4		12.5		3	12.5	3	8.1	4	8.	1		3.4	
	200.1 - 220.0	6	18.2	3	5.8	2	3.3	1		3.1		1	4.2	4	10.8	2	4.	1		3.4	
	220.1 - 240.0	1	3.0	4	7.7	1	1.6					1	4.2	1	2.7	1	2.				
	241.1 - 260.0	1		4		1						1		1		1					
	260.1 - 280.0	0		1		0						0		1							
	280.1 - 300.0	0	3.0	0	9.6	0	1.6					1	8.3	0	5.4		2				
	Total	33		52		61		32				24		37		50		26	3		
	Omitted	2		1		1		1								1					

UNIVERSITY OF MICHIGAN LIBRARIES

TABLE 49
Index of Substitution. Page 2. 15 years

School	Grade	Boys V No.	Boys V %	Boys VI No.	Boys VI %	Boys VII No.	Boys VII %	Boys VIII	Boys IX	Boys VIII and IX %	Girls V No.	Girls V %	Girls VI No.	Girls VI %	Girls VII No.	Girls VII %	Girls VIII	Girls IX	Girls VIII and IX %
Public School	Seconds																		
	80.0—	0	0.0	3	5.0	1	2.4	2	1	12.5	2	5.6	3	5.7	1	2.8	1		5.
	80.1 - 100.0	13	16.7	10	16.7	7	16.7	3		12.5	2	5.6	7	13.2	10	27.8	7	1	40.
	100.1 - 120.0	18	23.1	14	23.3	17	40.5	5	1	25.0	9	25.0	14	26.4	12	33.3	5		25.
	120.1 - 140.0	17	21.8	17	28.3	13	30.9	10		41.7	14	38.9	18	33.9	6	16.7	4		20.
	140.1 - 160.0	17	21.8	8	13.3	3	7.1	2		8.3	5	13.9	3	5.7	2	5.6	2		10.
	160.1 - 180.0	8	10.3	3	5.0	0	0.0				3	8.3	3	5.7	5	13.9			
	180.1 - 200.0	2	2.6	1	1.7	1	2.4				1	2.8	3	5.7					
	200.1 - 220.0	3	3.8	2	3.3						0		2	3.7					
	220.1 - 240.0			1							0		0						
	240.1 - 260.0			1	3.3						0		0						
	Total	78		60		42		22	2		36		53		36		19	1	
	Omitted	2		2		1											1		
Parochial School	80.0—	1	3.0	1	1.9	2	3.3	2		6.2	1	4.2	0	0.0	1	2.	0		00.0
	80.1 - 100.0	3	9.1	5	9.6	10	16.7	8		25.0	1	4.2	3	8.1	11	22.	3		11.1
	100.1 - 120.0	8	24.2	13	25.0	20	33.3	5		15.6	8	33.3	10	27.0	16	32.	16	2	66.7
	120.1 - 140.0	4	12.1	11	21.1	13	21.7	9		28.1	6	25.0	9	24.3	10	20.	5	1	22.2
	140.1 - 160.0	10	30.3	12	23.1	8	13.3	6		18.7	4	16.7	4	10.8	8	16.			
	160.1 - 180.0	3	9.1	5	9.6	3	5.0	1		3.1	2	8.3	4	10.8	2	4.			
	180.1 - 200.0	2	6.1	2	3.8	4	6.7	0			1	4.2	4	10.8	1	2.			
	200.1 - 220.0	0	0.	1	1.9			1		3.1	0		1	2.7	0	0.			
	220.1 - 240.0	2		2							1		2		0				
	240.1 - 260.0	0	6.1	0	3.8						0	4.2	0	5.4	1	2.			
	Total	33		52		60		32			24		37		50		24	3	
	Omitted	2		1		2		1							1		2		

TABLE 50
Index of Substitution. Page 3. 15 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
		No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	Seconds	7	8.7	8	13.3	4	9.5	3	1	16.7		3	8.3	5	9.4	2	5.6	4		19.0	
	80.0—	20	25.0	16	26.7	14	33.3	4		16.7		6	16.7	16	30.2	16	44.4	7	1	38.1	
	80.1 - 100.0	21	26.2	16	26.7	14	33.3	7	1	33.3		12	33.3	20	37.7	9	25.0	6		28.6	
	100.1 - 120.0	15	18.8	7	11.7	6	14.3	5		20.8		8	22.2	6	11.3	7	19.4	2		9.5	
	120.1 - 140.0	11	13.7	5	8.3	2	4.7	3		12.5		4	11.1	5	9.4	2	5.5	0			
	140.1 - 160.0	4	5.0	3	5.0	1	2.4					3	8.3	1	1.9			1		4.8	
	160.1 - 180.0	1	1.2	1	1.7	1	2.4														
	180.1 - 200.0	1		4																	
	200.1 - 220.0																				
	220.1 - 240.0		1.2		6.7																
	240.1 - 260.0																				
	Total	80		60		42		22	2			36		53		36		20	1		
	Omitted			2		1															
Parochial School	80.0—	1	3.1	6	11.5	6	9.8	2		6.2		2	8.3	1	2.9	2	4.1	3	1	13.8	
	80.1 - 100.0	7	21.9	10	19.2	15	24.6	10		31.2		5	20.8	6	17.1	14	28.6	8	1	31.0	
	100.1 - 120.0	5	15.6	15	28.8	19	31.1	9		28.1		7	29.2	8	22.9	17	34.7	9		31.0	
	120.1 - 140.0	7	21.9	10	19.2	14	22.9	5		15.6		4	16.7	5	14.3	11	22.4	6		20.7	
	140.1 - 160.0	6	18.7	6	11.5	3	4.9	5		15.6		3	12.5	8	22.8	4	8.2		1	3.4	
	160.1 - 180.0	3	9.4	1	1.9	1	1.6	0				1	4.2	1	2.9	0					
	180.1 - 200.0	2	6.2	2	3.8	1	1.6	1		3.1		1	4.2	3	8.6	1	2.0				
	200.1 - 220.0	1		2		2						1		1							
	220.1 - 240.0													1							
	240.1 - 260.0		3.1		3.9		3.3						4.2	1	8.6						
	Total	32		52		61		32				24		35		49		26	3		
	Omitted	3		1		1		1						2		2					

UNIVERSITY OF MICHIGAN LIBRARY

TABLE 51
Index of Substitution. Page 4. 15 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Seconds	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	80.0—	14	17.9	11	18.3	7	17.1	4		18.2		8	22.2	11	20.8	3	8.6	5		23.8	
	80.1 - 100.0	23	29.5	13	21.7	16	39.0	7	2	40.9		5	13.9	18	33.9	16	45.7	10		47.6	
	100.1 - 120.0	13	16.7	13	21.7	7	17.1	4		18.2		6	16.7	9	17.0	7	20.0	1	1	9.5	
	120.1 - 140.0	5	6.4	8	13.3	3	7.3	0		0.0		3	8.3	4	7.5	6	17.1	1		4.8	
	140.1 - 160.0	5	6.4	3	5.0	2	4.9	2		9.1		5	13.9	5	9.4	1	2.8	2		9.5	
	160.1 - 180.0	2	2.6	2	3.3	3	7.3	1		4.5		1	2.8	4	7.5						
	180.1 - 200.0	0		0	0.0	1	2.4	1		4.5		0		0							
	200.1 - 220.0	2	2.6	4	6.7	1	2.4	0		0.0		1	2.8	0							
	220.1 - 240.0	1	1.3	0	0.0			1		4.5		1	2.8	0							
	240.1 - 260.0	2	2.6	2	3.3							1	2.8	2	3.8						
	260.1 - 280.0	1	1.3	0								1	2.8	0				1		4.8	
	280.1 - 300.0	1	1.3	0								1	2.8	0							
	300.1+	9	11.5	4	6.7	1	2.4					3	8.3	0		2	5.7				
	Total	78		60		41		20	2			36		53		35		20			
	Omitted	2		2		2		2								1					
Parochial School	80.0—	6	18.2	12	23.5	12	20.0	7		21.2		5	20.8	3	8.3	7	14.	6	1	24.1	
	80.1 - 100.0	4	12.1	8	15.7	18	30.0	6		18.2		5	20.8	9	25.0	11	22.	8	1	31.0	
	100.1 - 120.0	5	15.1	17	33.3	9	15.0	9		27.3		6	25.0	5	13.9	12	24.	4	0	13.8	
	120.1 - 140.0	3	9.1	3	5.9	4	6.7	4		12.1		1	4.2	8	22.2	7	14.	1	0	3.4	
	140.1 - 160.0	2	6.1	2	3.9	7	11.7	0		0.0		1	4.2	0	0.0	3	6.	2	1	10.3	
	160.1 - 180.0	0		3	5.9	3	5.0	1		3.0		1	4.2	3	8.3	3	6.	1		3.4	
	180.1 - 200.0	0		1	2.0	1	1.7	1		3.0		0		0		1	2.	1		3.4	
	200.1 - 220.0	2	6.1	0		1	1.7	0				1	4.2	1	2.9	1	2.	1		3.4	
	220.1 - 240.0	5	15.1	1	2.0	2	3.3	1		3.0		2	8.3	0		1	2.	2		6.9	
	240.1 - 260.0	1	3.0	1	2.0	2	3.3	0				0		0		0					
	260.1 - 280.0	0		1	2.0	0		1		3.0		2	8.3	1	2.9	3	6.				
	280.1 - 300.0	2	6.1	1	2.0	0		0				0		0		0					
	300.1+	3	9.1	1	2.0	1	1.7	3		9.1		0		6	16.7	1	2.				
	Total	33		51		60		33				24		36		50		26	3		
	Omitted	2		2		2		1						1		1					

TABLE 52

Accuracy of Substitution. Page 1. 14 years

School	Grade	Girls										Boys									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100	10	13.7	10	18.5	8	23.5	5		23.8		7	17.9	10	18.2	6	18.7	4		15.4	
	98	15	20.5	9	16.7	11	32.3	7		33.2		9	23.1	4	7.3	5	15.6	11	1	46.1	
	96	11	15.1	13	24.1	3	8.8	2	2	19.0		7	17.9	13	23.6	6	18.7	2		7.7	
	94	9	12.3	3	5.5	3	8.8	2		9.5		5	12.8	10	18.2	5	15.6	3		11.5	
	92	4	5.5	7	13.0	4	11.8	0				4	10.3	4	7.3	4	12.5	2		7.7	
	90	3	4.1	3	5.5	2	5.9	1		4.8		1	2.6	5	9.1	1	3.1				
	88	5	6.8	2	3.7	1	2.9	2		9.5		2	5.1	2	3.6	2	6.2				
	86	3	4.1	1	1.8	1	2.9							3	5.4	2	6.2	1		3.8	
	84	2	2.7	2	3.7									1	1.8						
	82	1	1.4	0										2	3.6						
	80 - 76	6	8.2	0								2	5.1					1		3.8	
	74 - 70	3	4.1	1	1.8	1	2.9					2	5.1	1	1.8	1	3.1		1	3.8	
	68 - 64	1	1.4	2	3.7																
	64—	0		1	1.8																
	Total	73		54		34		19	2			39		55		32		24	2		
	Omitted	13		14		9		3				4		4		11		0	1		
Parochial School	100	1	3.0	8	17.0	6	12.8	11		30.1		2	9.1	4	10.0	15	30.6	5	2	21.9	
	98	8	24.2	11	23.4	12	25.5	6	1	19.4		5	22.7	7	17.5	11	22.4	6	1	21.9	
	96	5	15.1	9	19.1	8	17.0	3		8.3		3	13.6	7	17.5	5	10.2	4		12.5	
	94	5	15.1	1	2.1	4	8.5	3		8.3		3	13.6	5	12.5	3	6.1	4		12.5	
	92	3	9.1	5	10.6	3	6.4	1		2.8		2	9.1	2	5.0	5	10.2	1		3.1	
	90	0		2	4.3	5	10.6	2		5.6		1	4.5	1	2.5	1	2.0	2		6.2	
	88	1	3.0	4	8.5	1	2.1	2		5.6		4	18.2	3	7.5	2	4.1	2		6.2	
	86	2	6.1	0		4	8.5	4		11.1		1	4.5	1	2.5	2	4.1	3		9.4	
	84	2	6.1	1	2.1	1	2.1	0	1	2.8		1	4.5	3	7.5	2	4.1	1		3.1	
	82	1	3.0	1	2.1	1	2.1	1	1	5.6		0		1	2.5	2	4.1	0			
	80 - 76	3	9.1	4	8.5	1	2.1	0				0		4	10.0	0		1		3.1	
	74 - 70	2	6.1	0		1	2.1	0				0		2	5.0	1	2.0	0			
	68 - 64	0		1	2.1	0		0				0		0		0		0			
	64—	0		0		0		0				0		0		0		0			
	Total	33		47		47		33	3			22		40		49		29	3		
	Omitted	5		12		18		4	0			4		3		6		2	0		

UNIVERSITY OF MICHIGAN LIBRARIES

TABLE 53
Accuracy of Substitution. Page 2. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100	19	26.0	22	40.0	21	61.7	11	1	57.1		17	44.7	26	47.3	10	31.2	15	1	61.5	
	98	25	34.2	15	27.3	6	17.6	2		9.5		4	10.5	16	29.1	7	21.9	5		19.2	
	96	11	15.1	8	14.5	5	14.7	4	1	23.8		7	18.4	1	1.8	7	21.9	1		3.8	
	94	5	6.8	4	7.3	0						4	10.5	4	7.3	5	15.6	2		7.7	
	92	4	5.5	1	1.8	1	2.9	1		4.8		1	2.6	4	7.3	2	6.2	1		3.8	
	90	4	5.5	1	1.8							2	5.3	2	3.6	0					
	88	3	4.1	2	3.6			1		4.8		1	2.6	0		1	3.1				
	86											2	5.3	1	1.8						
	84					1	2.9							0							
	82													1	1.8						
	80	1	1.4																		
	80—	1	1.4	2	3.6														1	3.8	
	Total	73		55		34		19	2			38		55		32		24	2		
	Omitted	13		13		9		3	0			5		4		11		0	1		
Parochial School	100	10	30.3	18	37.5	16	34.0	16	1	47.2		10	43.5	19	47.5	12	24.5	9	2	34.4	
	98	6	18.2	16	33.3	14	29.8	6		16.7		3	13.0	4	10.0	23	46.9	10		31.2	
	96	8	24.2	4	8.3	8	17.0	5		13.9		1	4.3	4	10.0	7	14.3	5	1	18.7	
	94	3	9.1	3	6.2	2	4.3	1	2	8.3		3	13.0	3	7.5	4	8.2	3		9.4	
	92	2	6.1	0		3	6.4	2		5.6		3	13.0	1	2.5	3	6.1	1		3.1	
	90			2	4.2	0		3		8.3		1	4.3	4	10.0			0			
	88			2	4.2	2	4.3					0		2	5.0			1			
	86			1	2.1	1	2.1					1	4.3	0							
	84			0		0								0							
	82			1	2.1	0								1	2.5						
	80	2	6.1	0		1	2.1					1	4.3	0							
	80—	2	6.1	1	2.1	0								2	5.0						
	Total	33		48		47		33	3			23		40		49		29	3		
	Omitted	5		11		18		4	0			3		3		6		2	0		

TABLE 54

Accuracy of Substitution. Page 3. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100	36	49.3	23	41.8	17	50.0	13	1	66.7		19	50.0	31	56.4	16	50.0	13		50.0	
	98	22	30.1	13	23.6	10	29.4	2		9.5		8	21.0	10	18.2	11	34.4	10	1	42.3	
	96	4	5.5	10	18.2	4	11.8	1	1	9.5		5	13.2	7	12.7	3	9.4	0			
	94	4	5.5	3	5.4	1	2.9	3		14.3		3	7.9	3	5.4	1	3.1	1		3.8	
	92	2	2.7	2	3.6	0						0		1	1.8	1	3.1				
	90	0		2	3.6	0						1	2.6	0					1	3.8	
	88	2	2.7	2	3.6	2	5.9					1	2.6	0							
	86	1	1.4											0							
	84													1	1.8						
	82													1	1.8						
	80																				
	80—	2	2.7									1	2.6								
	Total	73		55		34		19	2			38		55		32		24	2		
	Omitted	13		13		9		3	0			5		4		11		0	1		
Parochial School	100	12	36.4	28	59.6	25	53.2	23	3	74.3		12	52.2	17	42.5	30	61.2	15	2	53.1	
	98	13	39.4	8	17.0	8	17.0	5		14.3		3	13.0	9	22.5	10	20.4	5	1	18.7	
	96	2	6.1	4	8.5	5	10.6	3		8.6		5	21.7	6	15.0	2	4.1	4		12.5	
	94	1	3.0	3	6.4	1	2.1	1		2.9		2	8.7	2	5.0	3	6.1	3		9.4	
	92	0		1	2.1	2	4.3							1	2.5	4	8.2	2		6.2	
	90	2	6.1			1	2.1							2	5.0						
	88	1	3.0			2	4.3							0							
	86	0				0								0							
	84	1	3.0			1	2.1							1	2.5						
	82	0										1	4.3	1	2.5						
	80	1	3.0	1	2.1									1	2.5						
	80—			2	4.3	2	4.3														
	Total	33		47		47		32	3			23		40		49		29	3		
	Omitted	5		12		18		5	0			3		3		6		2	0		

UNIVERSITY OF MICHIGAN LIBRARIES

TABLE 55

Accuracy of Substitution. Page 4. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
PUBLIC SCHOOL	100	31	43.3	23	41.8	11	32.3	7	1	38.1		10	26.3	23	41.8	12	37.5	7		27.0	
	98	7	9.7	8	14.5	10	29.4	1		4.8		5	13.2	4	7.3	3	9.4	5		19.2	
	96 - 94	6	8.3	6	10.9	5	14.7	4		19.0		5	13.2	6	10.9	4	12.5	3		11.5	
	92 - 90	7	9.7	3	5.4	1	2.9	1		4.8		2	5.3	5	9.1	5	15.6	2	1	11.5	
	88 - 86	4	5.6	6	10.9	1	2.9	2		9.5		6	15.8	6	10.9	4	12.5	4	1	19.2	
	84 - 82	1	1.4	5	9.1	1	2.9	1		4.8		0		4	7.3	1	3.1	0			
	80 - 78	4	5.6	0		1	2.9	0				2	5.3	0		1	3.1	1		3.8	
	76 - 74	2	2.8	0		1	2.9	0				2	5.3	1	1.8	2	6.2	0			
	72 - 70	2	2.8	0		1	2.9	1	1	9.5		1	2.6	1	1.8			1		3.8	
	68 - 66	2	2.8	1	1.8	0		1		4.8		2	5.3	0				1		3.8	
	64 - 62	1	1.4	1	1.8	1	2.9	0				1	2.6	1	1.8						
	60 - 58	1	1.4	0		1	2.9	0				0		1	1.8						
	56 - 54	2	2.8	2	3.6	0		0				1	2.6	1	1.8						
	54—	2	2.8	0		0		1		4.8		1	2.6	2	3.6						
	Total	72		55		34		19	2			38		55		32		24	2		
	Omitted	14		13		9		3	0			5		4		11		0	1		
PAROCHIAL SCHOOL	100	6	18.2	14	29.1	23	48.9	11	3	39.9		9	39.1	14	35.0	20	40.8	10	2	37.4	
	98	4	12.1	9	18.8	3	6.4	10		28.7		4	17.4	6	15.0	7	14.3	5		15.7	
	96 - 94	4	12.1	8	16.7	4	8.5	3		8.6		4	17.4	3	7.5	5	10.2	1		3.1	
	92 - 90	2	6.1	6	12.5	4	8.5	0				2	8.7	1	2.5	2	4.1	3		9.4	
	88 - 86	2	6.1	4	8.3	2	4.3	2		5.7		1	4.3	0		1	2.0	3		9.4	
	84 - 82	1	3.0	1	2.1	4	8.5	1		2.9		1	4.3	2	5.0	3	6.1	2		6.3	
	80 - 78	2	6.1	2	4.2	2	4.3	1		2.9		0		3	7.5	5	10.2	2		6.3	
	76 -74	5	15.1	3	6.2	0		1		2.9		0		2	5.0	2	4.1	2		6.3	
	72 - 70	2	6.1	0		1	2.1	0				0		1	2.5	2	4.1	1		3.1	
	68 - 66	1	3.0	1	2.1	1	2.1	1		2.9		1	4.3	1	2.5	0		0			
	64 - 62	1	3.0	0		2	4.3	0				0		2	5.0	0		0			
	60 - 58	0		0		1	2.1	0				0		1	2.5	0		0	1	3.1	
	56 - 54	1	3.0	0		0		0				0		1	2.5	2	4.1	0			
	54—	2	6.1	0		0		2		5.7		1	4.3	3	7.5	0		0			
	Total	33		48		47		32	3			23		40		49		29	3		
	Omitted	5		11		18		5	0			3		3		6		2	0		

TABLE 56

Accuracy of Substitution. Page 1. 15 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No	No.	%	
PUBLIC SCHOOL	100	37	46.2	26	43.2	15	35.7	13	2	62.5		11	30.5	26	49.0	18	50.0	15	1	76.2	
	98	15	18.7	17	28.3	15	35.7	5		20.8		13	36.1	19	35.8	13	36.1	1		4.8	
	96	14	17.5	6	10.0	4	9.5	1		4.2		6	16.7	3	5.7	2	5.5	3		14.3	
	94	6	7.5	1	1.7	5	11.9	0		0.0		1	2.8	2	3.8	0	0.0	1		4.8	
	92	4	5.0	2	3.3	1	2.4	1		4.2		2	5.5	3	5.7	3	8.3				
	90	1	1.2	1	1.7	1	2.4	1		4.2		2	5.5								
	88	0	0.0	2	3.3	0		0				0	0.0								
	86	1	1.2	2	3.3	0		0				1	2.8								
	84	1	1.2	2	3.3	0		0													
	82	0	0.0	1	1.7	0		0													
	80-76	0	0.0			0		1		4.2											
	74-70	1	1.2			1	2.4														
	68-64	0																			
	64—	0																			
	Total	80		60		42		22	2			36		53		36		20	1		
	Omitted	0		2		1		0	0			0		0		0		0	0		
PAROCHIAL SCHOOL	100	11	33.2	18	34.6	25	41.0	15		46.9		12	50.0	23	62.1	27	54.0	8	3	37.9	
	98	12	36.4	18	34.6	10	16.4	9		28.1		6	25.0	5	13.5	13	26.0	8		27.6	
	96	5	15.1	6	11.5	10	16.4	4		12.5		3	12.5	4	10.8	6	12.0	6		20.7	
	94	3	9.1	4	7.7	5	8.2	2		6.2		1	4.2	2	5.4	1	2.0	0		0.0	
	92	0	0.0	2	3.8	3	4.9	0		0.0		1	4.2	1	2.7	2	4.0	0		0.0	
	90	0	0.0	2	3.8	5	8.2	0		0.0				0	0.0	1	2.0	2		6.9	
	88	1	3.0	0	0.0	2	3.3	1		3.1				0	0.0			1		3.4	
	86	0	0.0	1	1.9	0	0.0	0		0.0				1	2.7			1		3.4	
	84	0	0.0	0	0.0	0	0.0	0		0.0				0	0.0						
	82	1	3.0	0	0.0	0	0.0	0		0.0				1	2.7						
	80-76			1	1.9	1	1.6	1		3.1											
	74-70																				
	68-64											1	4.2								
	64—																				
	Total	33		52		61		32				24		37		50		26	3		
	Omitted	2		1		1		1				0		0		1		0	0		

UNIVERSITY OF MICHIGAN LIBRARIES

TABLE 57

Accuracy of Substitution. Page 2. 15 years

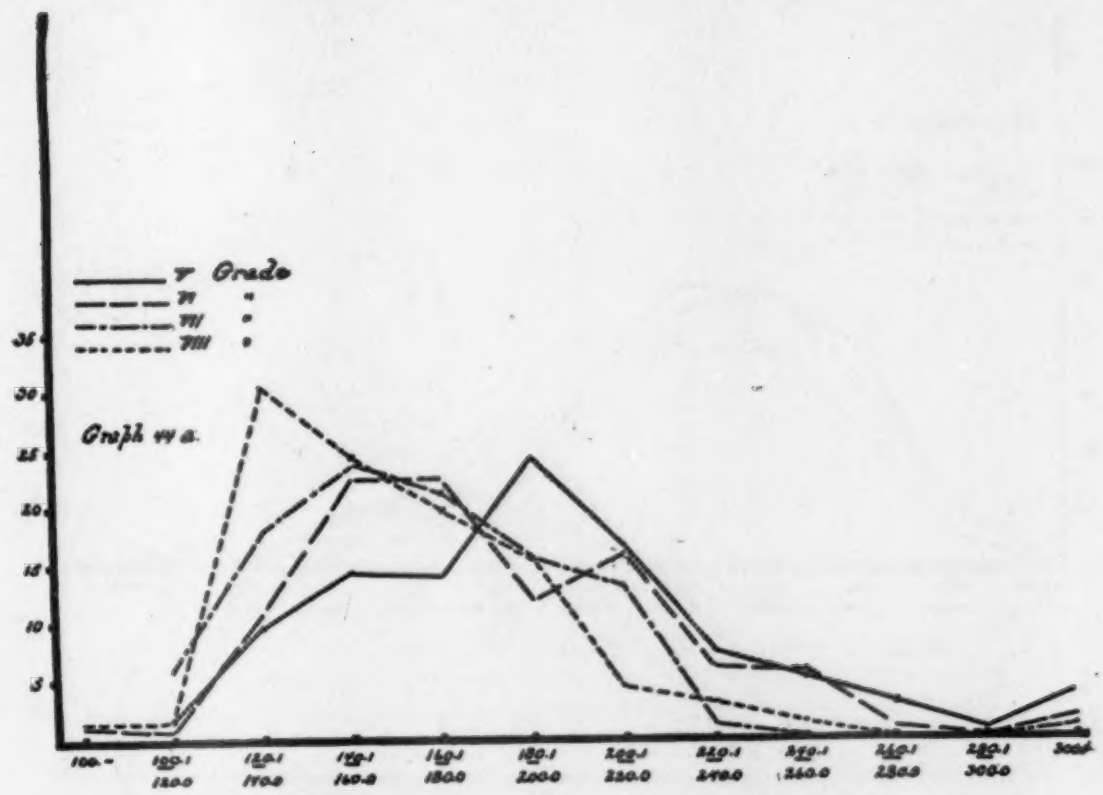
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100	49	61.2	38	63.3	27	64.3	19	2	87.5		19	52.8	25	47.2	25	69.4	13	1	66.7	
	98	16	20.0	12	20.0	9	21.4	2		8.3		8	22.2	19	35.8	3	8.3	3		14.3	
	96	9	11.2	5	8.3	3	7.1	0		0.0		4	11.1	5	9.4	5	13.9	3		14.3	
	94	3	3.7	1	1.7	1	2.4	0		0.0		2	5.5	3	5.7	0	0.0	1		4.8	
	92	0	0.0	1	1.7	0	0.0	1		4.2		1	2.8	1	1.9	1	2.8				
	90	2	2.5	1	1.7	0	0.0					1	2.8			2	5.5				
	88					1	2.4					0	0.0								
	86											1	2.8								
	84																				
	82																				
	80			1	1.7																
	54—	1	1.2	1	1.7	1															
	Total	80		60		42		22	2			36		53		36		20	1		
	Omitted	0		2		1		0	0			0		0		0		0	0		
Parochial School	100	19	57.6	29	55.8	32	52.4	21		65.4		12	50.0	22	59.5	31	62	16	2	62.1	
	98	8	24.2	9	17.3	14	22.9	5		15.6		6	25.0	7	18.9	12	24	8	1	31.0	
	96	4	12.1	6	11.5	4	6.5	3		9.4		1	4.2	6	16.2	2	4	2		6.9	
	94	2	6.1	5	9.6	6	9.8	1		3.1		2	8.3	0		3	6				
	92			0	0.0	2	3.3	1		3.1		3	12.5	0		1	2				
	90			3	5.8	0	0.0	0		0.0				0		1	2				
	88					1	1.6	0		0.0				1	2.7						
	86					1	1.6	0		0.0				0							
	84							1		3.1				0							
	82													1	2.7						
	80																				
	64—					1	1.6														
	Total	33		52		61		32				24		37		50		26	3		
	Omitted	2		1		1		1				0		0		1		0	0		

TABLE 58
Accuracy of Substitution. Page 3. 15 years

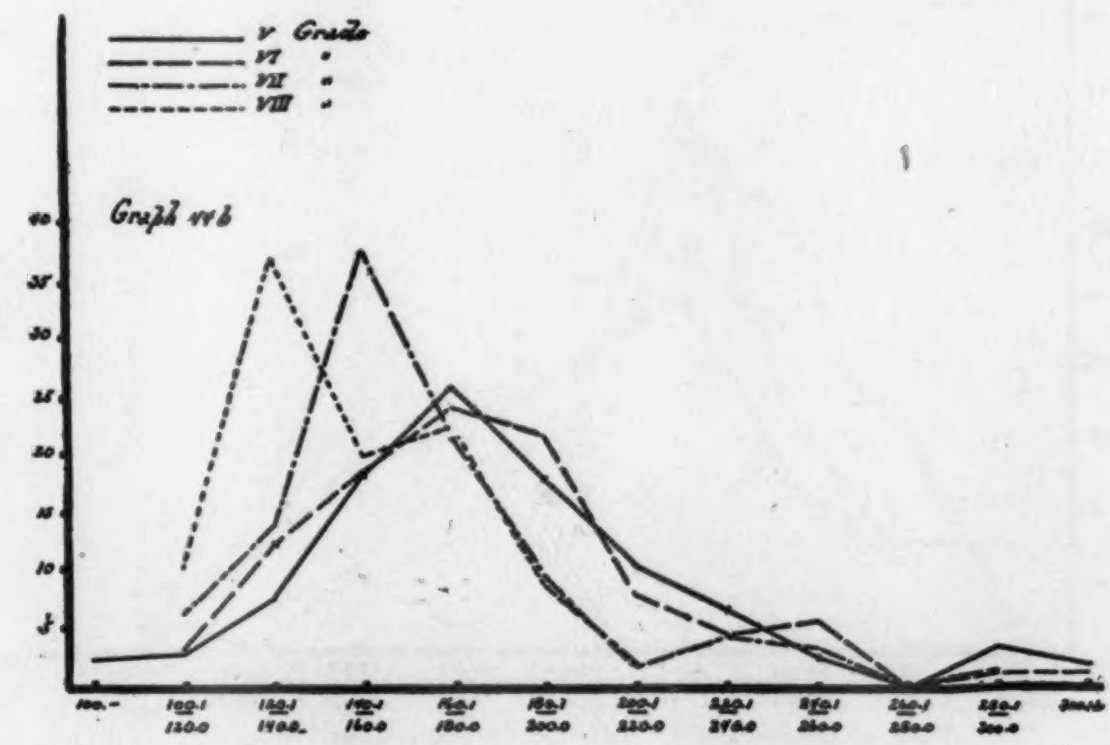
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100	53	66.2	32	53.3	27	64.3	12	2	58.3		21	58.3	31	58.6	21	58.3	16		76.2	
	98	15	18.7	16	26.6	8	19.0	6		25.0		7	19.4	13	24.5	10	27.8	3		14.3	
	96	6	7.5	5	8.3	6	14.3	3		12.5		4	11.1	4	7.5	2	5.5	1		4.7	
	94	2	2.5	2	3.3	0	0.0	1		4.2		3	8.3	3	5.7	3	8.3			0.0	
	92	1	1.2	0	0.0	1	2.4					0	0.0	1	1.9				1	4.7	
	90	0	0.0	0	0.0							1	2.8	1	1.9						
	88	2	2.5	3	5.0																
	86		0.0	0	0.0																
	84		0.0	1	1.7																
	82		0.0	0	0.0																
	80		0.0	1	1.7																
	80—	1	1.2																		
	Total	80		60		42		22	2			36		53		36		20	1		
	Omitted			2		1															
Parochial School	100	17	51.5	36	69.2	34	55.7	21		65.4		16	66.7	18	48.6	32	64.	18	2	68.9	
	98	9	27.3	5	9.6	12	19.7	9		28.1		6	25.0	8	21.6	12	24.	7		24.1	
	96	6	18.2	4	7.7	7	11.5	0		0.0		0	0.0	6	16.2	1	2.	0	1	3.4	
	94	0	0.0	5	9.6	2	3.3	1		3.1		0	0.0	3	8.1	3	6.	1		3.4	
	92	0	0.0	1	1.9	4	6.5			0.0		1	4.2	2	5.4	1	2.				
	90	1	3.0	0	0.0	1	1.6			0.0		1	4.2			0	0				
	88			0	0.0	1	1.6			0.0						0	0				
	86			0	0.0					0.0						0	0				
	84			1	1.9					0.0						0	0				
	82									0.0						1	2				
	80									0.0											
	80—							1		3.1											
	Total	33		52		61		32				24		37		50		26	3		
	Omitted	2		1		1										1					

TABLE 59
Accuracy of Substitution. Page 4. 15 years

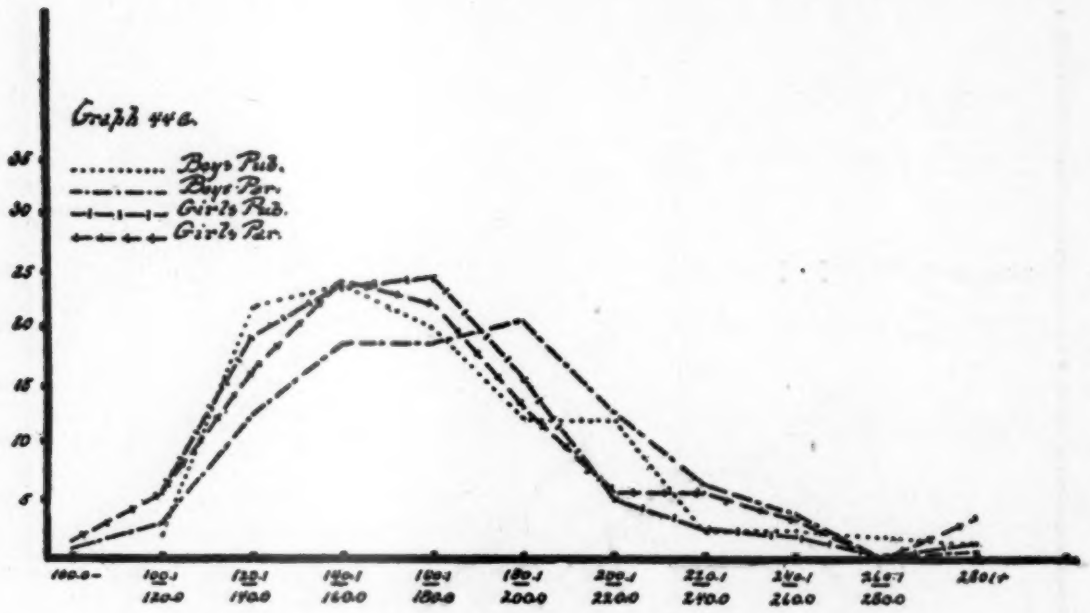
School	Grade	Boys V No.	Boys V %	Boys VI No.	Boys VI %	Boys VII No.	Boys VII %	Boys VIII	Boys IX	Boys VIII and IX %	Girls V No.	Girls V %	Girls VI No.	Girls VI %	Girls VII No.	Girls VII %	Girls VIII	Girls IX	Girls VIII and IX %
PUBLIC SCHOOL	%																		
	100	33	41.2	23	38.3	18	42.8	10	2	50.0	13	36.1	24	45.3	14	40.	10	1	52.4
	98	11	13.7	14	23.3	4	9.5	2		8.3	7	19.4	11	20.7	9	25.7	6		28.6
	96 and 94	10	12.5	7	11.7	9	21.4	2		8.3	1	2.8	9	17.0	3	8.6	1		4.8
	92 and 90	7	8.7	3	5.0	2	4.8	2		8.3	3	8.3	5	9.4	3	8.6	1		4.8
	88 and 86	5	6.2	1	1.7	3	7.1	1		4.2	2	5.5	2	3.8	1	2.8	2		9.5
	84 and 82	0		2	3.3	2	4.8	0			5	13.9	0		1	2.8			
	80 and 78	3	3.7	1	1.7	1	2.4	2		8.3	1	2.8	0		0				
	76 and 74	0		1	1.7	1	2.4	0			1	2.8	1	1.9	1	2.8			
	72 and 70	2	2.5	0		1	2.4	1		4.2	1	2.8	1	1.9	1	2.8			
	68 and 66	2	2.5	2	3.3	0		0			0								
	64 and 62	2	2.5	0		0		0			1	2.8							
	60 and 58	1	2.5	2	3.3	1	2.4	1		4.2	0								
	56 and 56—	4	5.0	4	6.7	0		1		4.2	1	2.8			2	5.7			
	Total	80		60		42		22	2						1				
	Omitted			2		1					36		53		35		20	1	
PAROCHIAL SCHOOL	100	10	30.3	22	42.3	26	42.6	14		43.7	13	54.2	14	37.8	18	36	16		55.2
	98	5	15.1	12	23.1	7	11.5	5		15.6	2	8.3	2	5.4	5	10	2	2	13.8
	96 and 94	4	12.1	5	9.6	8	13.1	3		9.4	1	4.2	4	10.8	8	16	2		6.9
	92 and 90	1	3.0	1	1.9	7	11.5	2		6.2	2	8.3	3	8.1	5	10	0		0.0
	88 and 86	0		3	5.8	3	4.9	1		3.1	2	8.3	0		2	4	1		3.4
	84 and 82	1	3.0	2	3.8	3	4.9	1		3.1	0		3	8.1	4	8	2	1	10.3
	80 and 78	1	3.0	2	3.8	1	1.6	0			1	4.2	3	8.1	2	4	0		0.0
	76 and 74	2	6.1	0		2	3.3	0			0		1	2.7	1	2	1		3.4
	72 and 70	2	6.1	1	1.9	0		1		3.1	2	8.3	0		0		0		0.0
	68 and 66	3	9.1	2	3.8	2	3.3	0			0		1	2.7	1	2	1		3.4
	64 and 62	2	6.1	1	1.9	0		2		6.2	0				1	2	0		0.0
	60 and 58	0				0		0			1	4.2			0		0		0.0
	56 and 56—	2	6.1	1	1.9	2	3.3	3		9.4	0		6	16.2	3	6	1		3.4
	Total	33		52		61		32			24		37		50		26	3	
	Omitted	2		1		1		1							1				



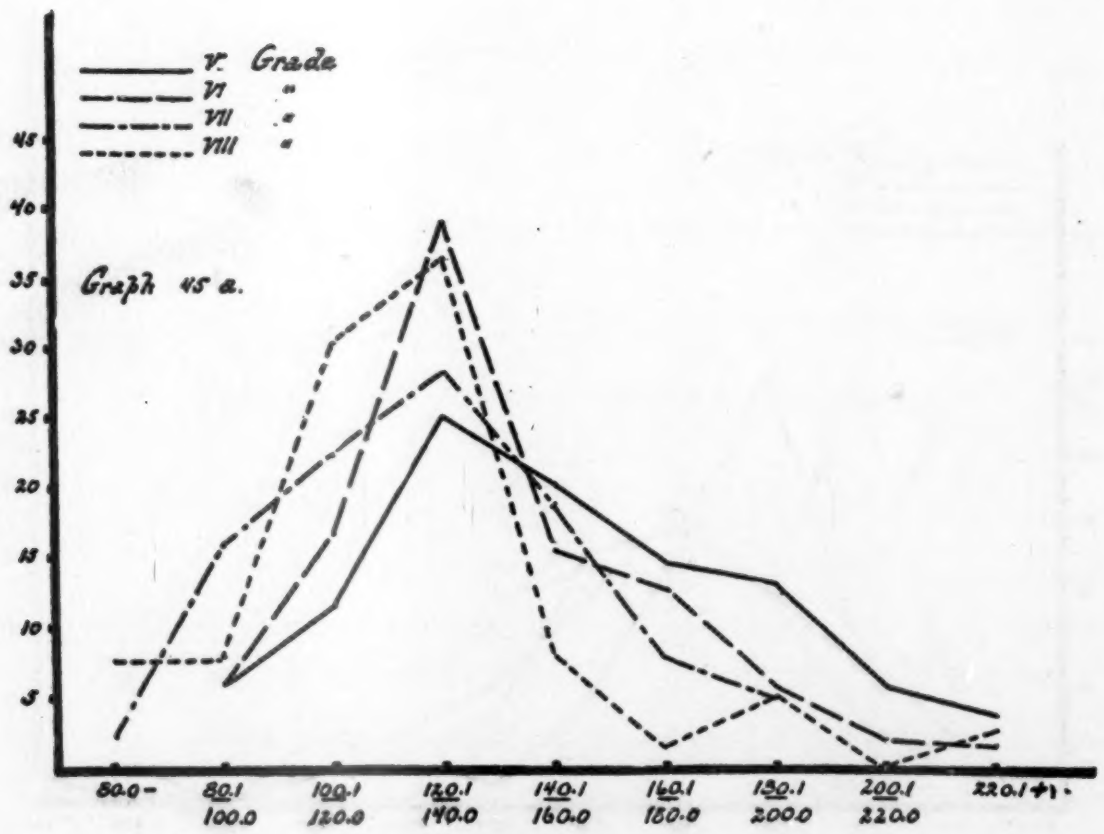
INDEX OF SUBSTITUTION. PAGE 1. 14 YEARS. BOYS.



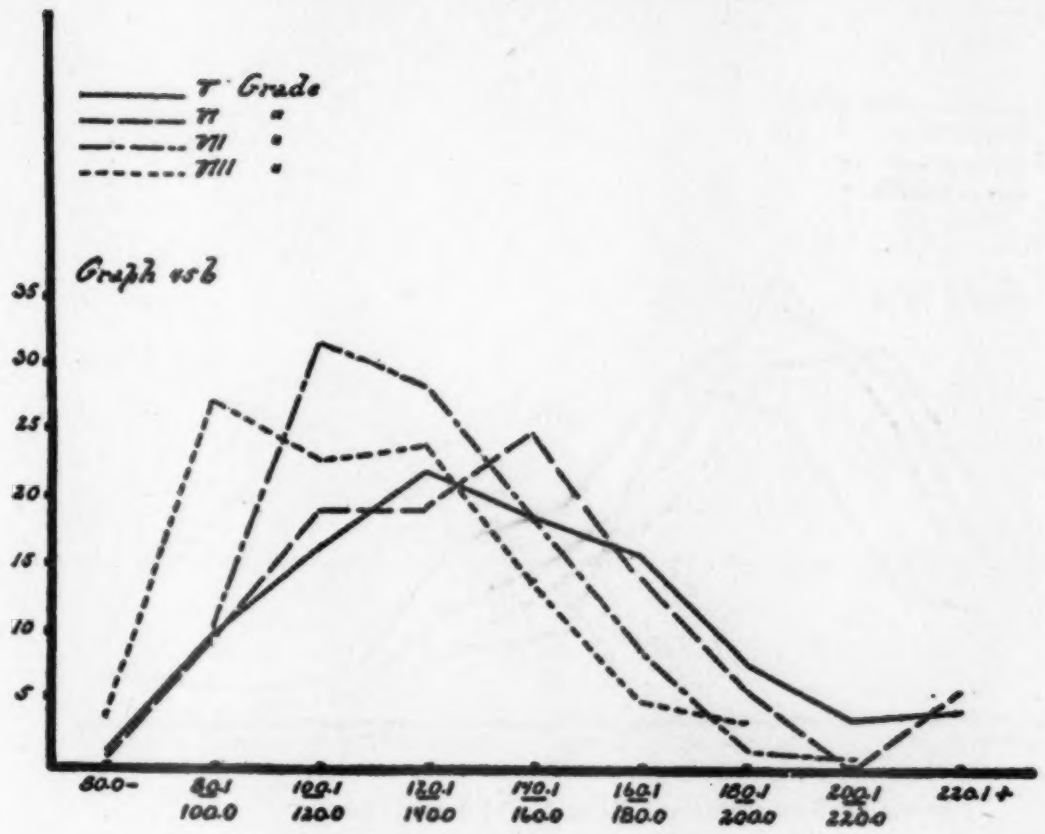
INDEX OF SUBSTITUTION. PAGE 1. 14 YEARS. GIRLS.



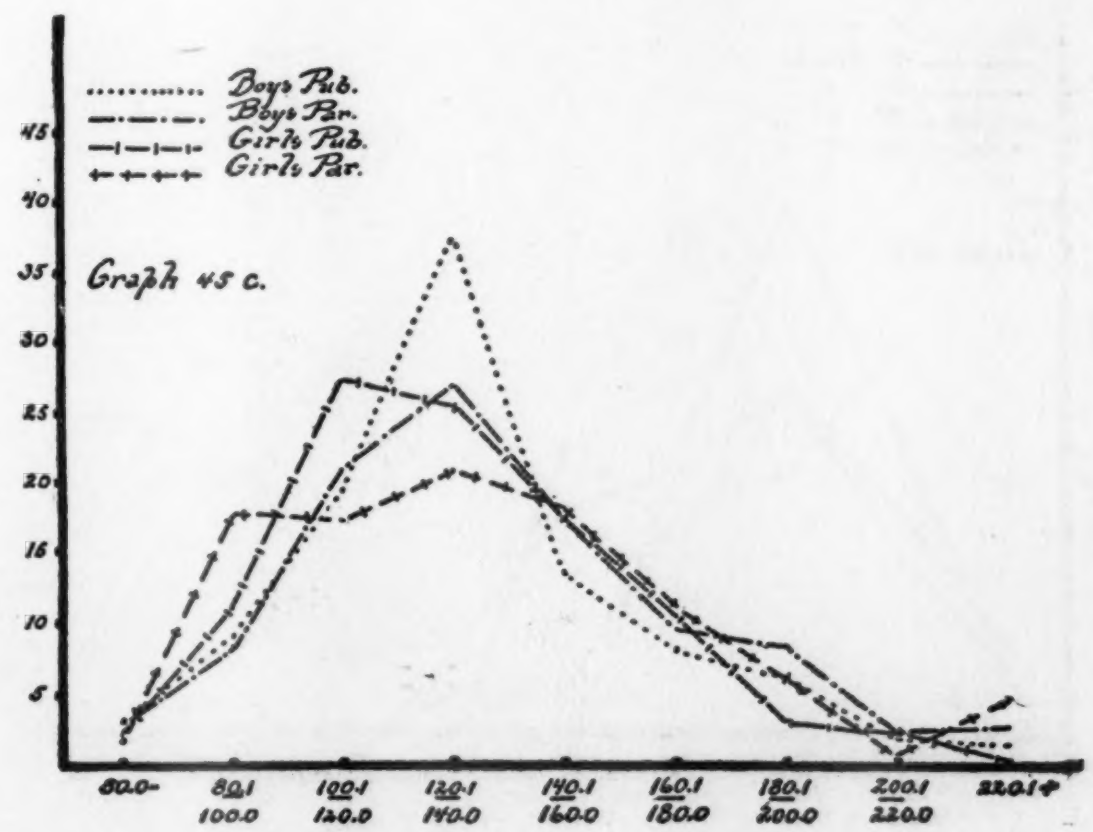
INDEX OF SUBSTITUTION. PAGE 1. 14 YEARS.



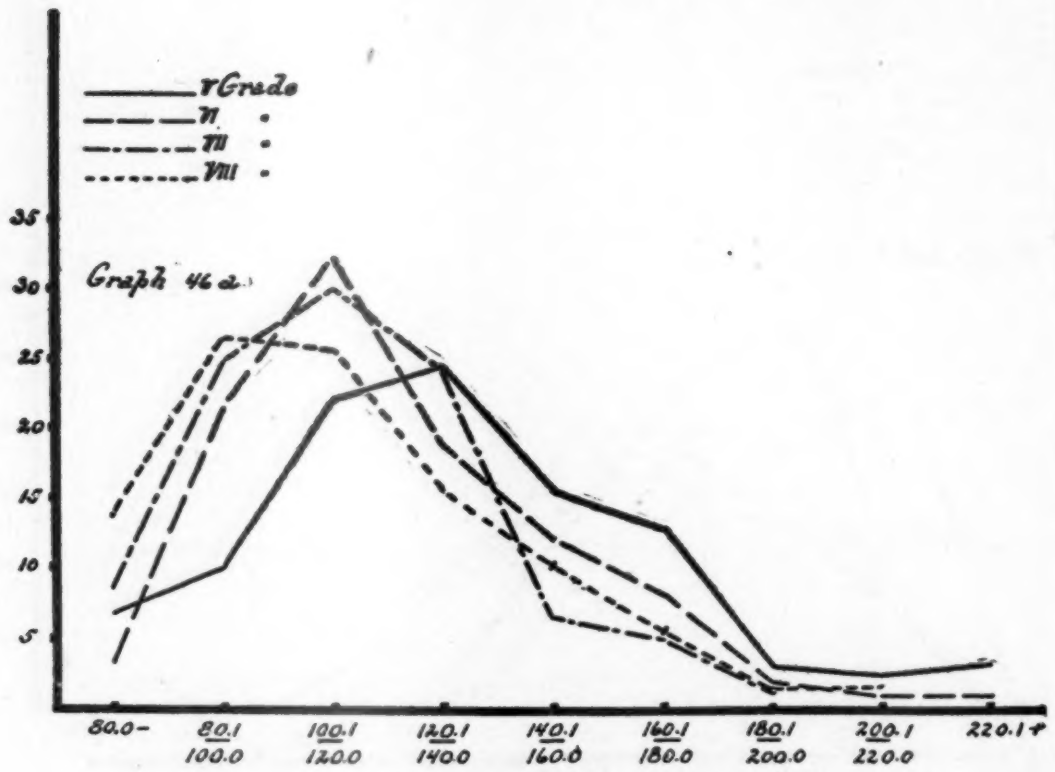
INDEX OF SUBSTITUTION. PAGE 2. 14 YEARS. BOYS.



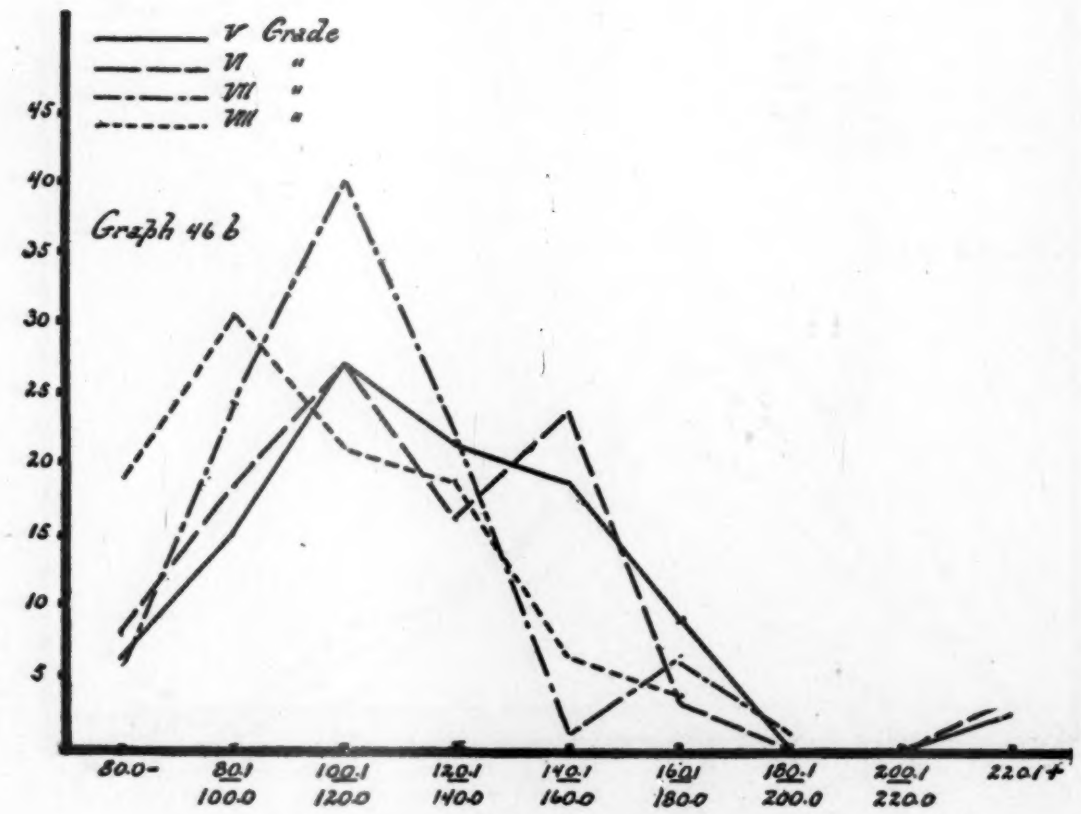
INDEX OF SUBSTITUTION. PAGE 2. 14 YEARS. GIRLS.



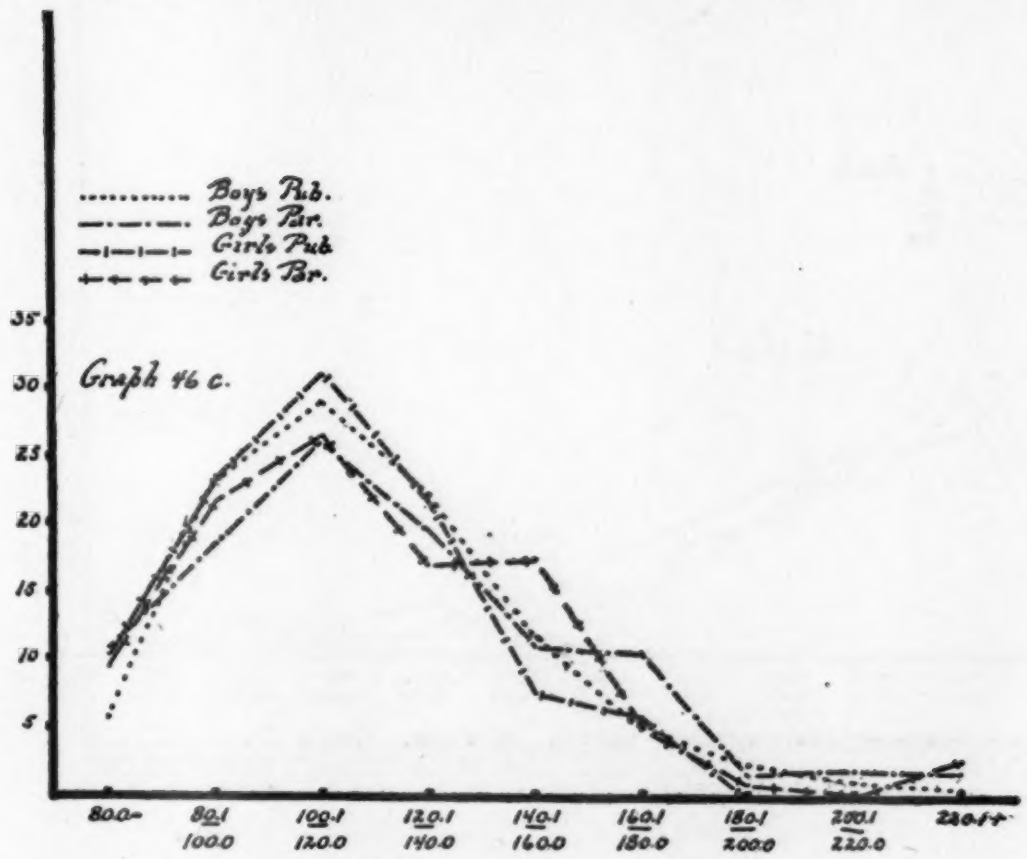
INDEX OF SUBSTITUTION. PAGE 2. 14 YEARS.



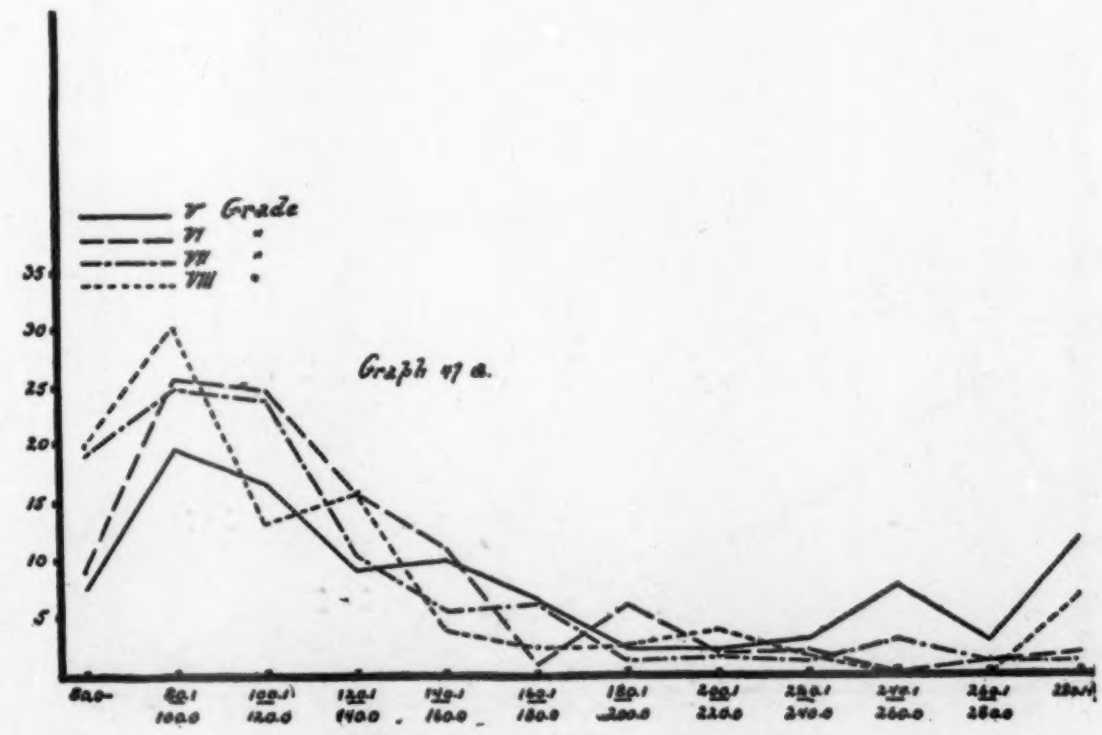
INDEX OF SUBSTITUTION. PAGE 3. 14 YEARS. BOYS.



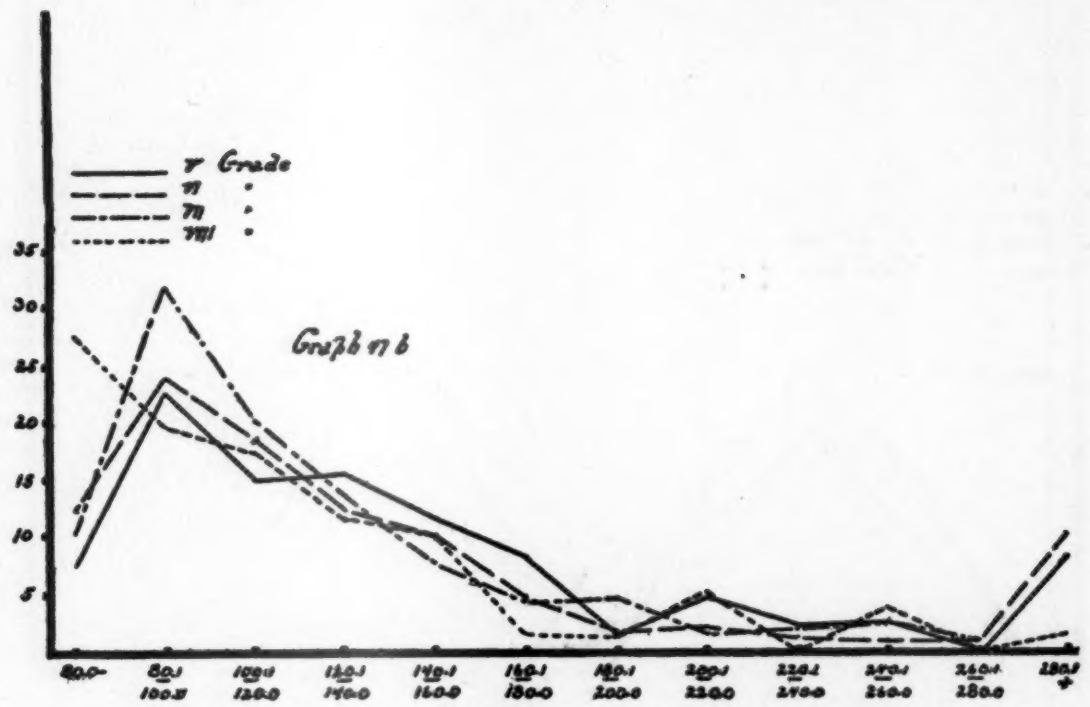
INDEX OF SUBSTITUTION. PAGE 3. 14 YEARS. GIRLS.



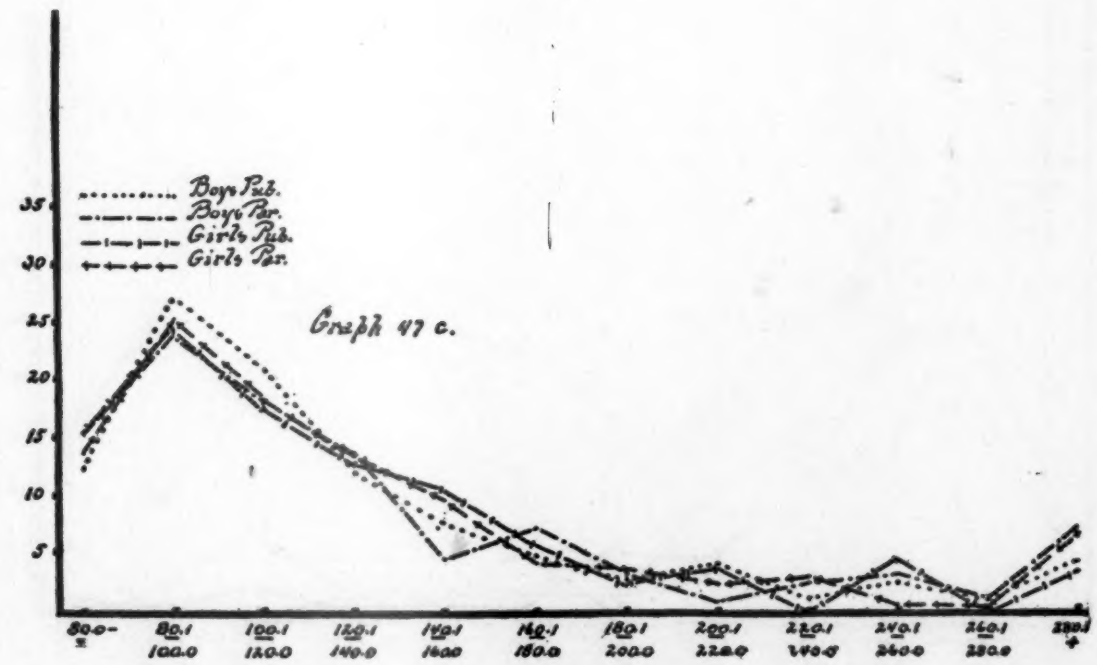
INDEX OF SUBSTITUTION. PAGE 3. 14 YEARS.



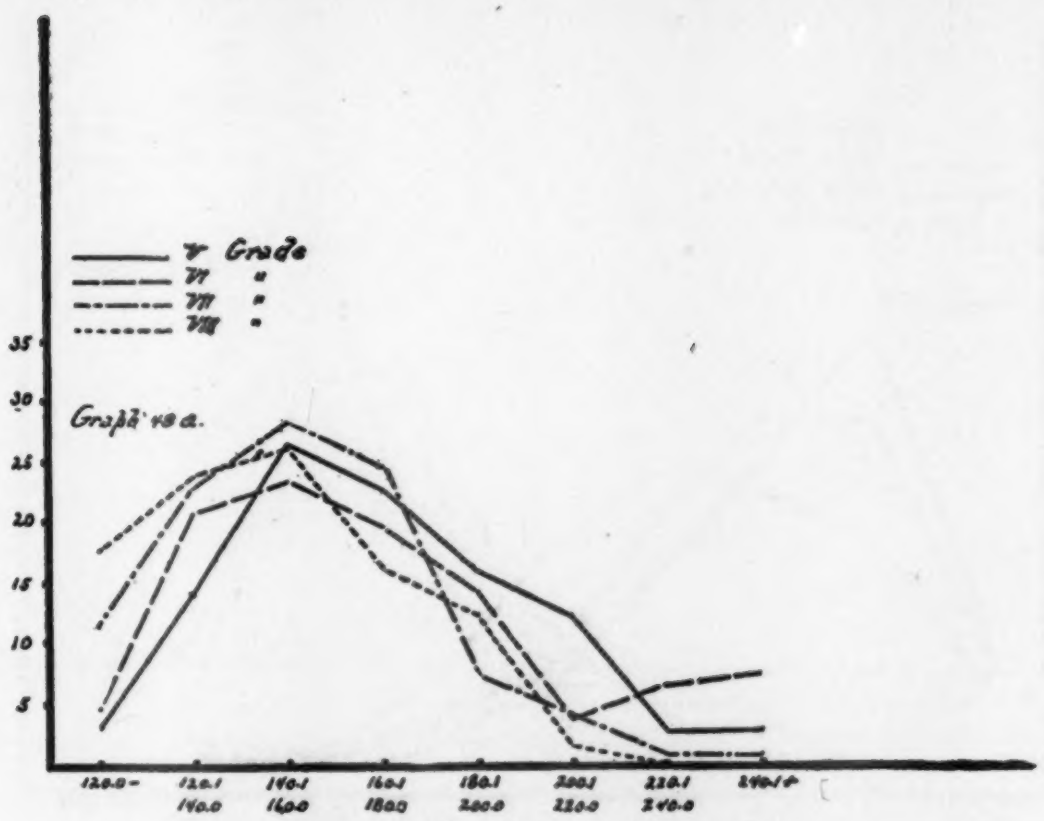
INDEX OF SUBSTITUTION. PAGE 4. 14 YEARS. BOYS.



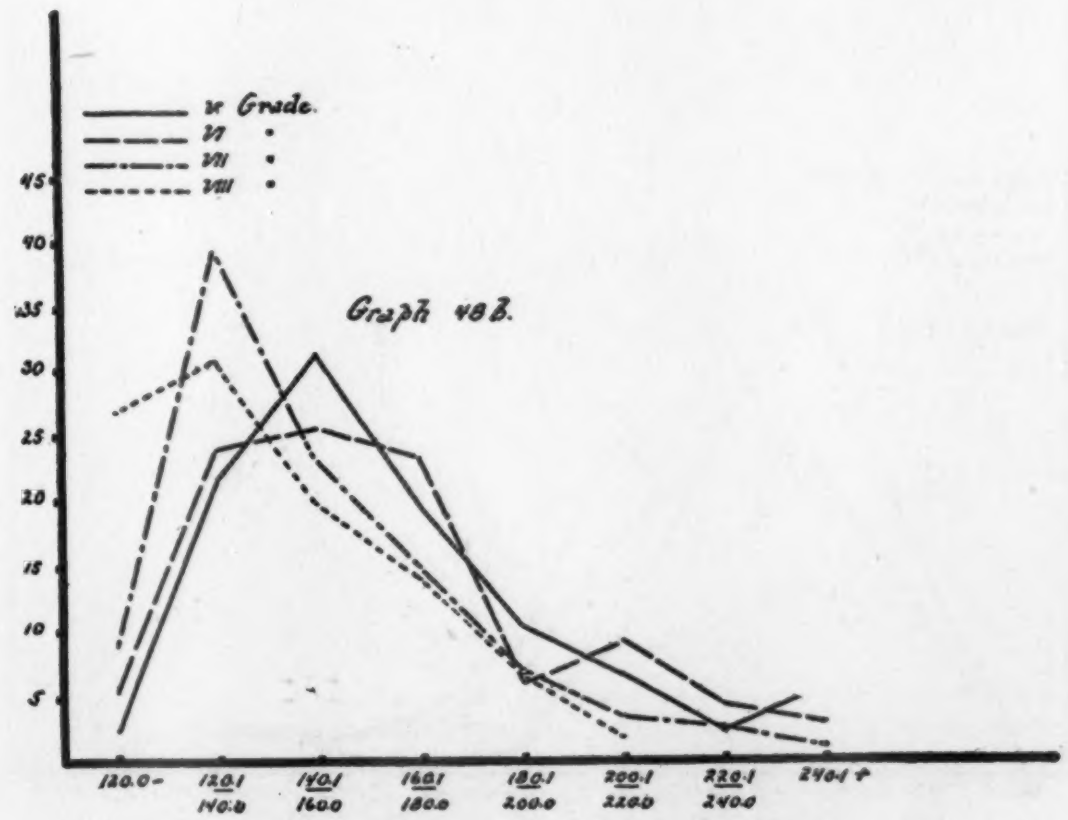
INDEX OF SUBSTITUTION. PAGE 4. 14 YEARS. GIRLS.



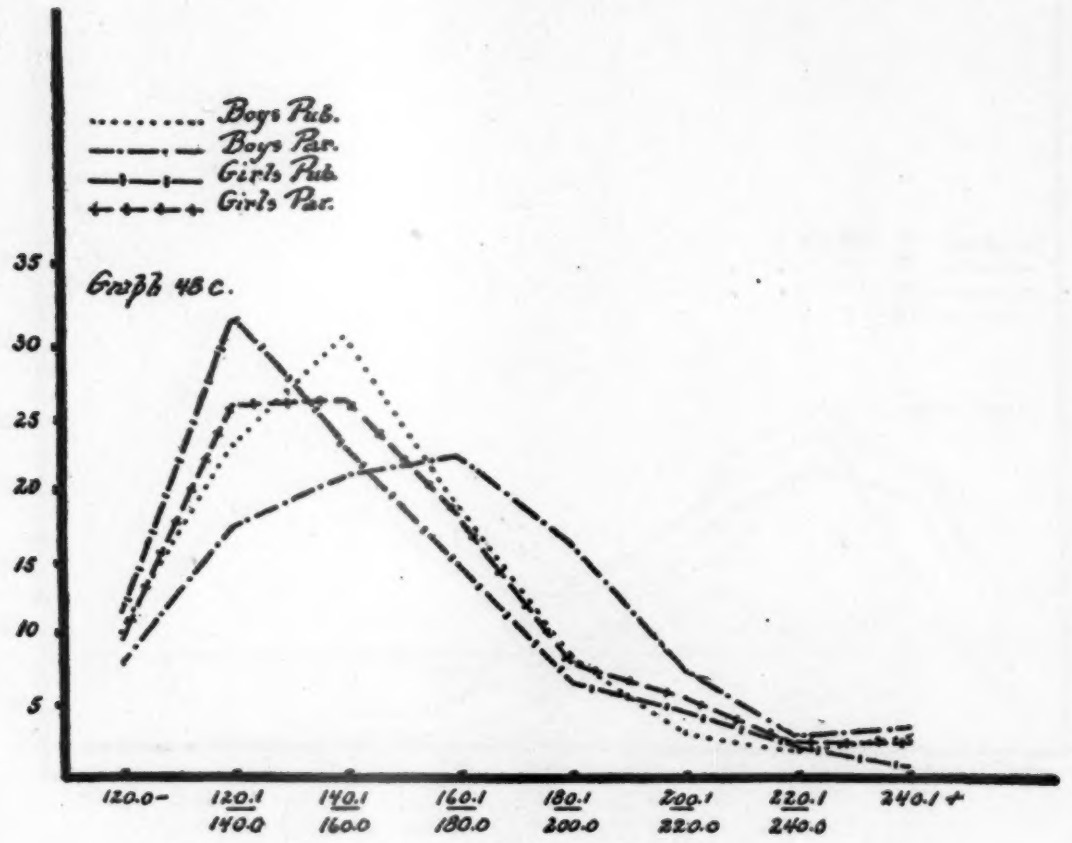
INDEX OF SUBSTITUTION. PAGE 4. 14 YEARS.



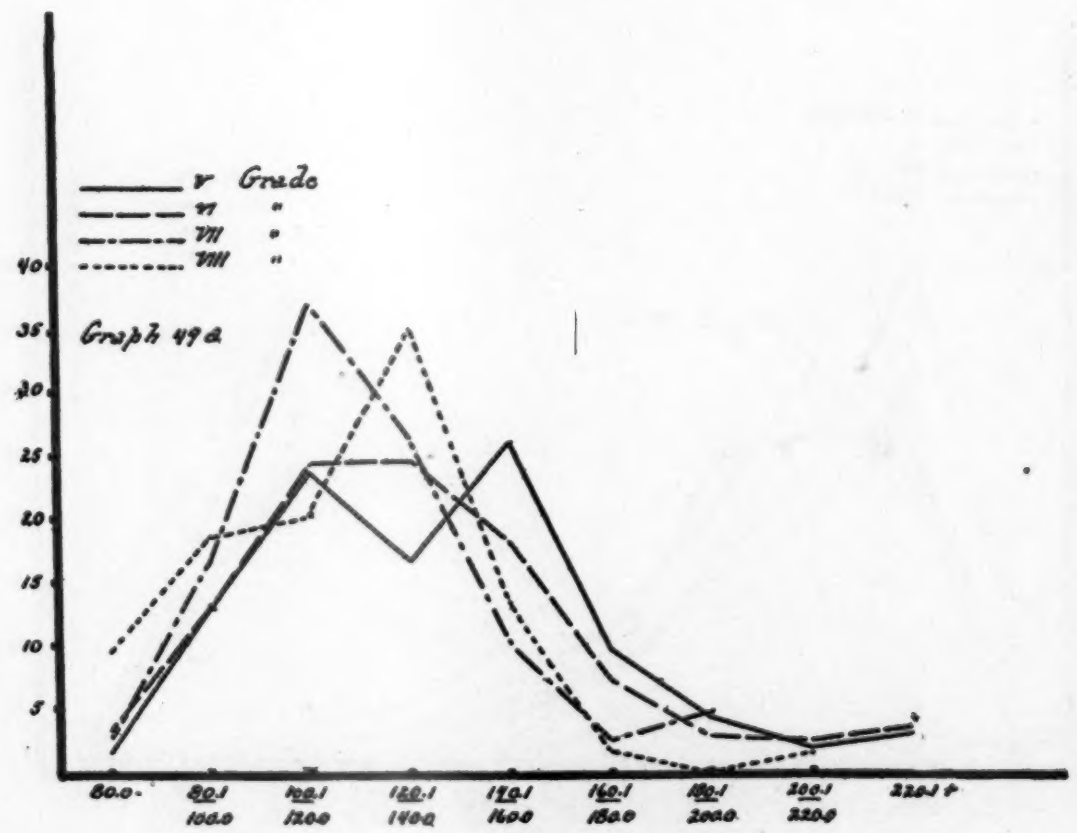
INDEX OF SUBSTITUTION. PAGE 1. 15 YEARS. BOYS.



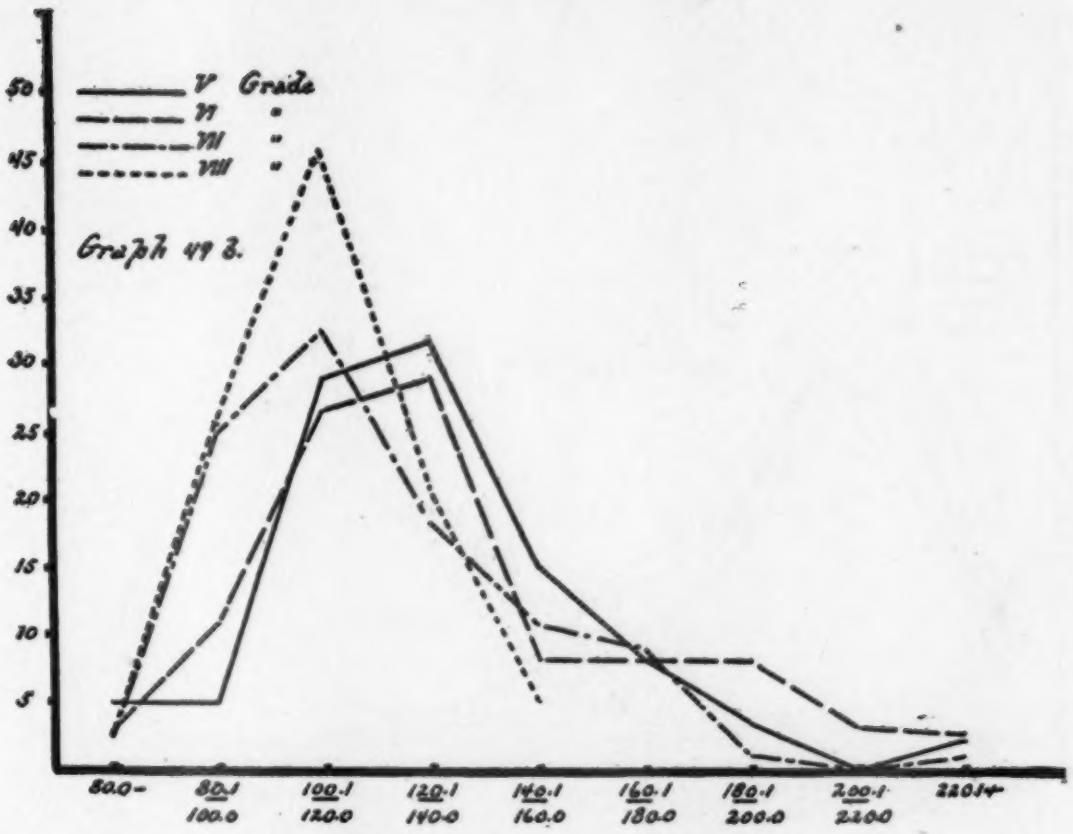
INDEX OF SUBSTITUTION. PAGE 1. 14 YEARS. GIRLS.



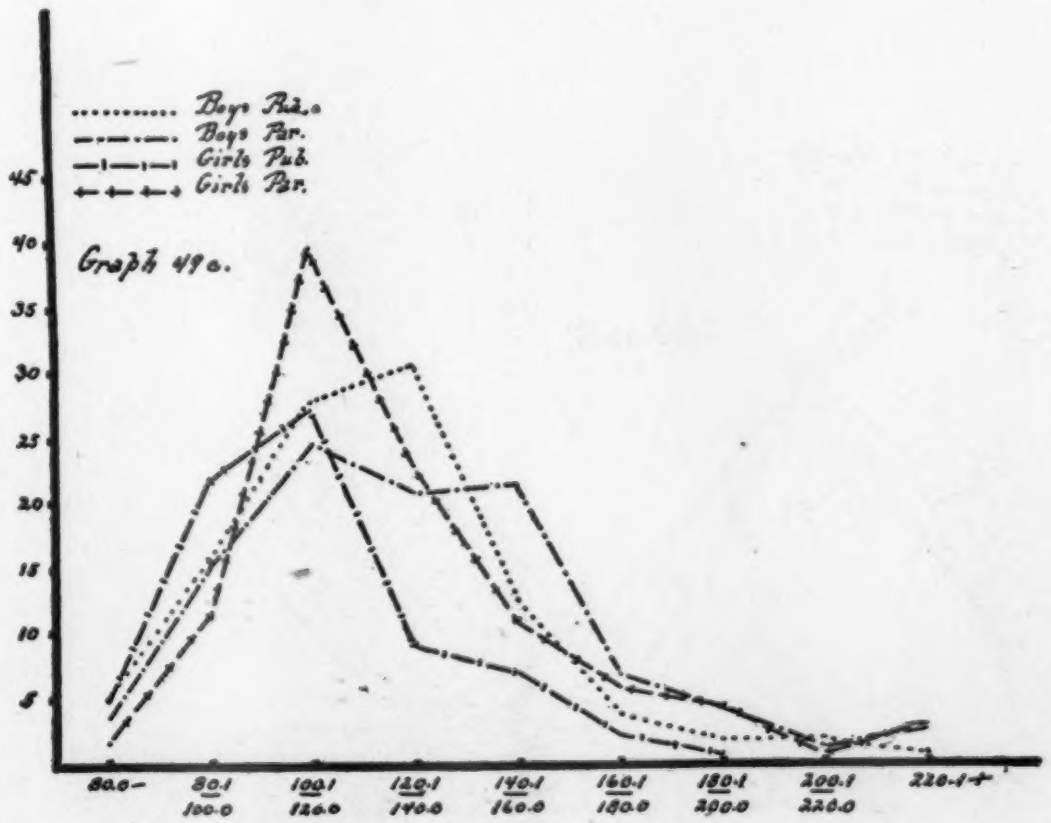
INDEX OF SUBSTITUTION. PAGE 1. 15 YEARS.



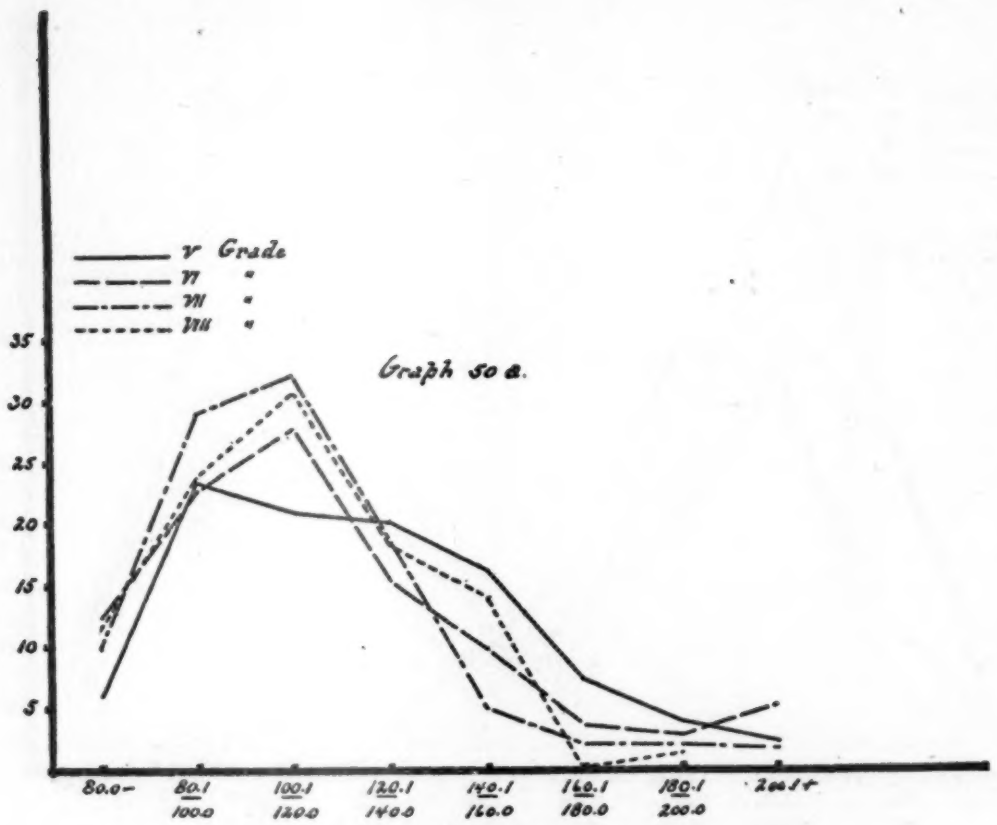
INDEX OF SUBSTITUTION. PAGE 2. 15 YEARS. BOYS.



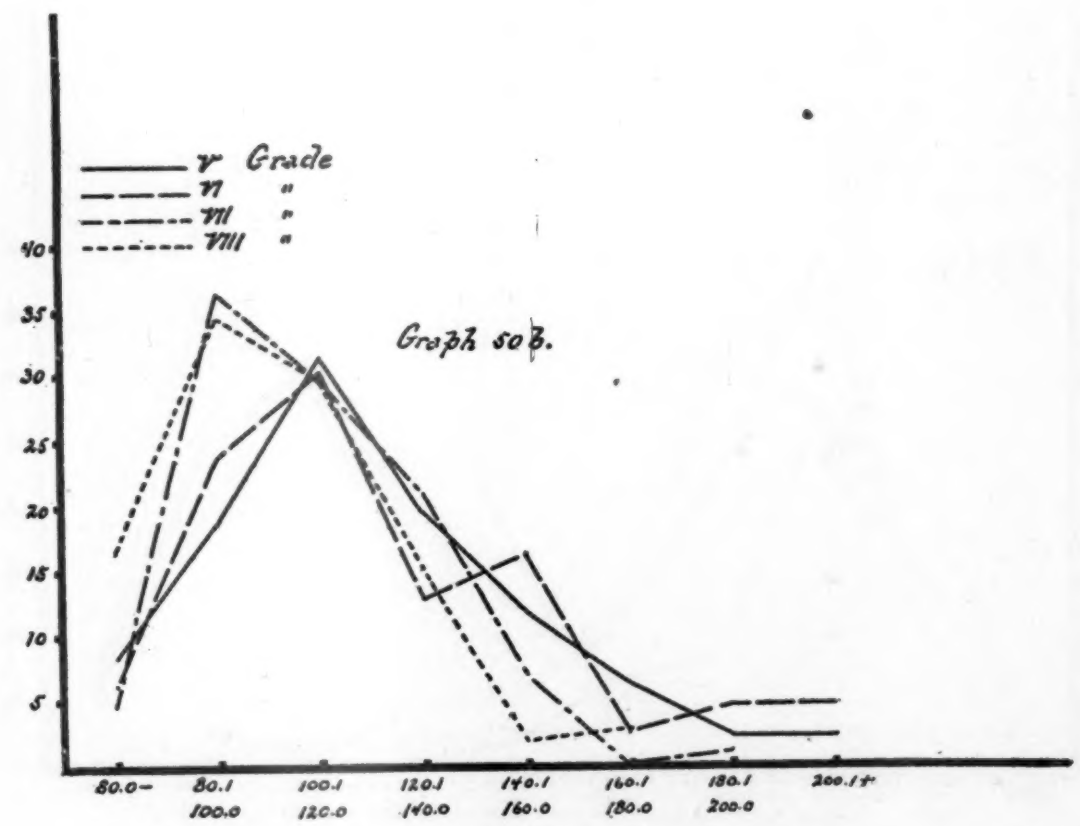
INDEX OF SUBSTITUTION. PAGE 2. 15 YEARS. -GIRLS.



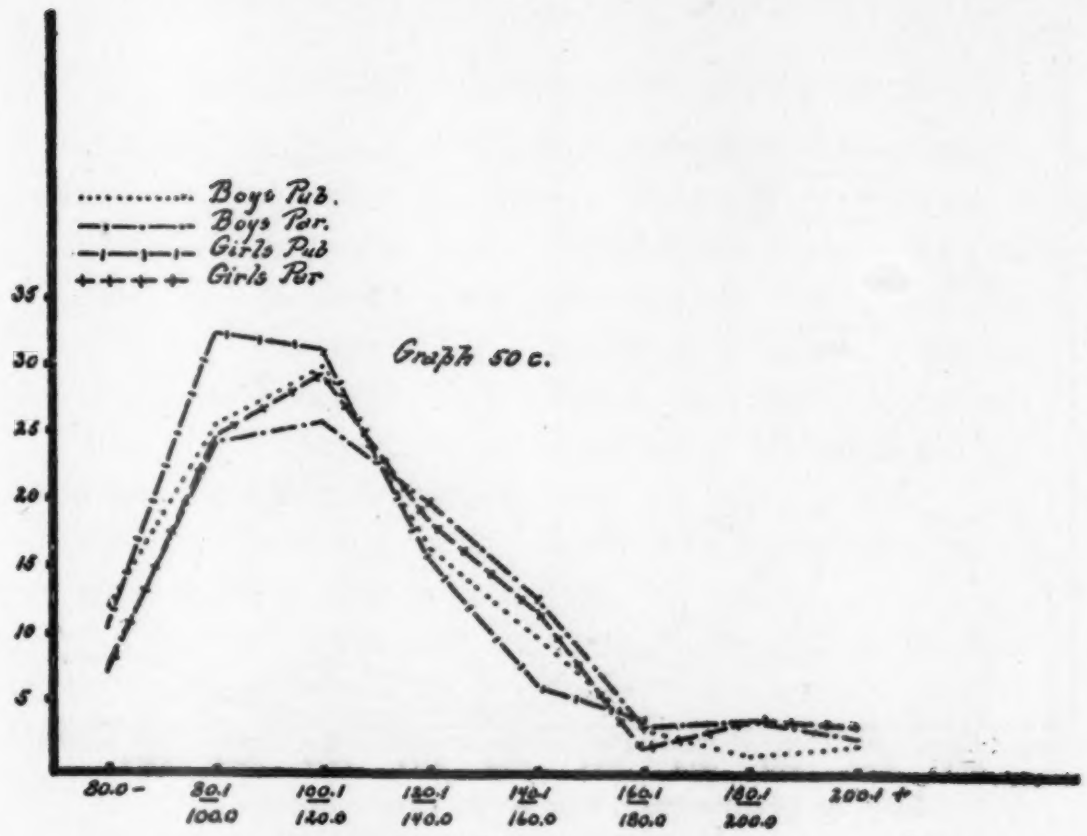
INDEX OF SUBSTITUTION. PAGE 2. 15 YEARS.



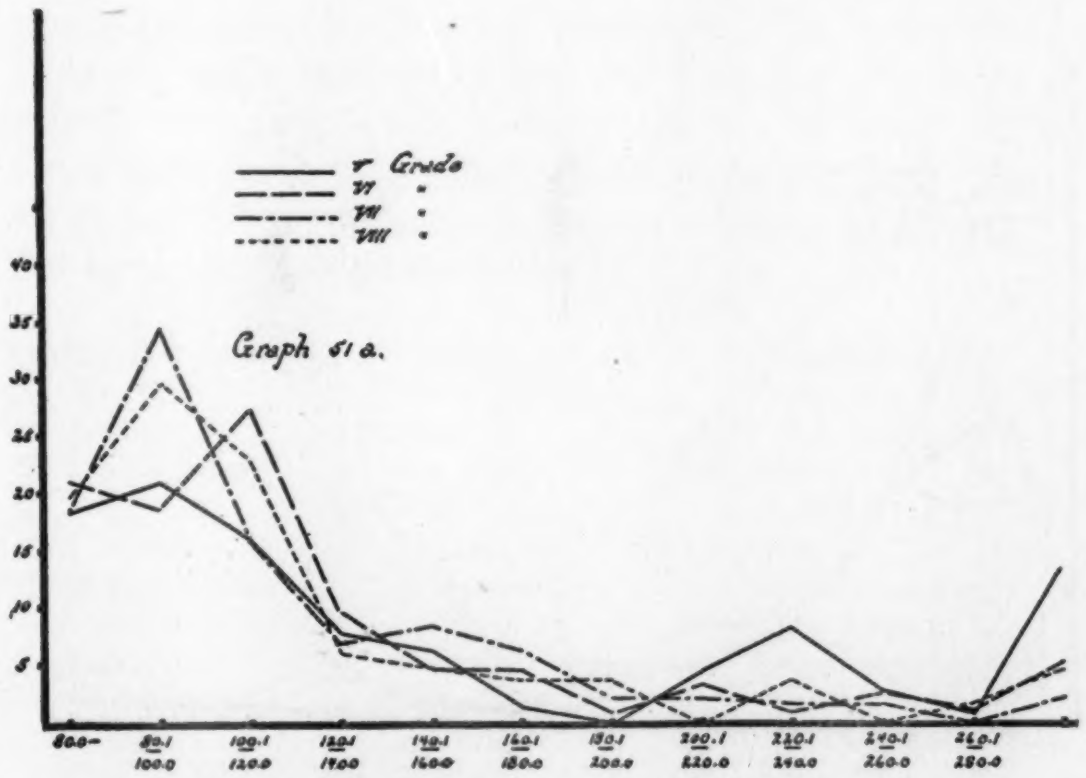
INDEX OF SUBSTITUTION. PAGE 3. 15 YEARS. BOYS.



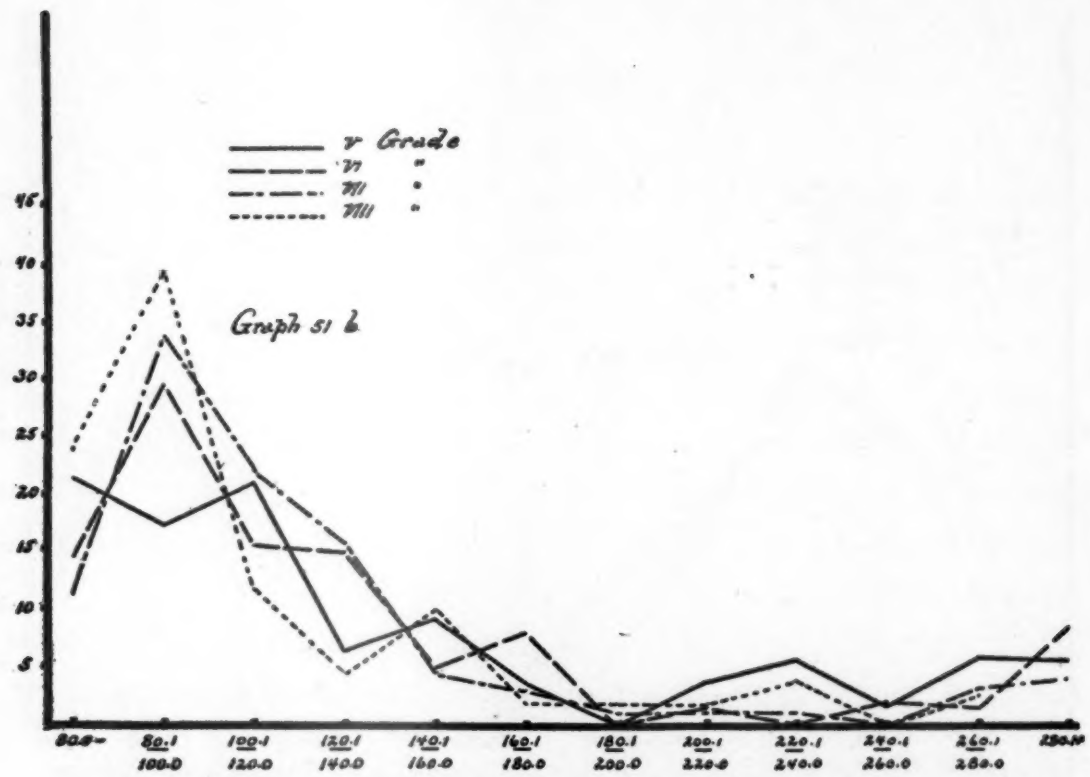
INDEX OF SUBSTITUTION. PAGE 3. 15 YEARS. GIRLS.



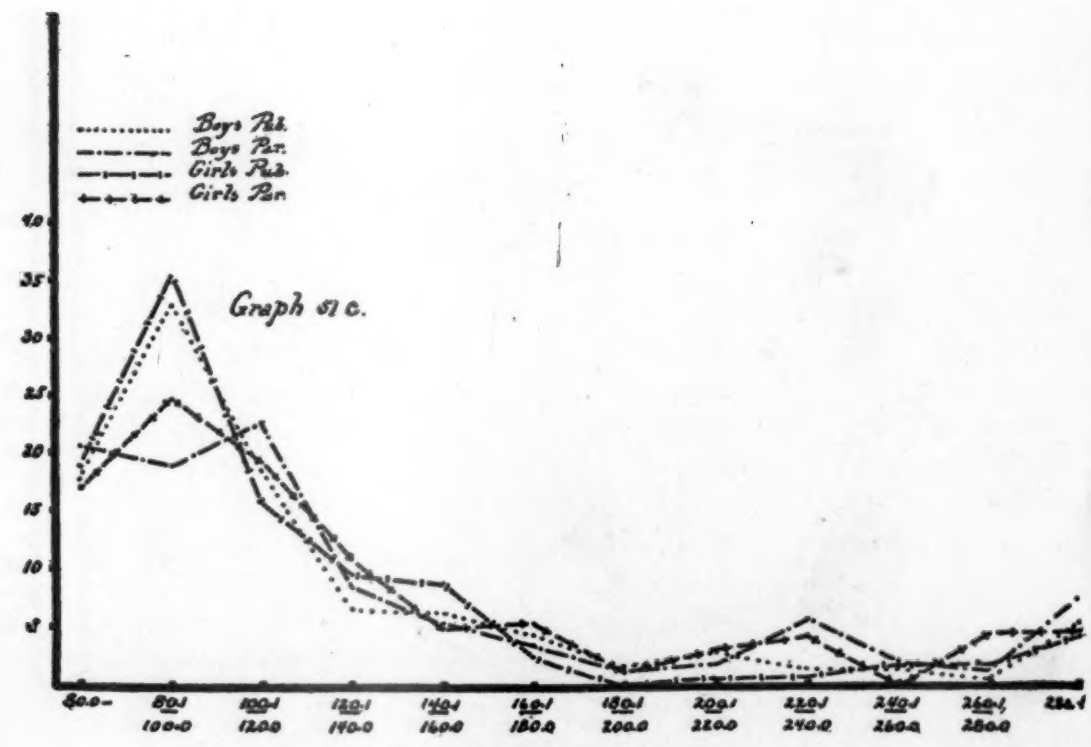
INDEX OF SUBSTITUTION. PAGE 3. 15 YEARS.



INDEX OF SUBSTITUTION. PAGE 4. 15 YEARS. BOYS.



INDEX OF SUBSTITUTION. PAGE 4. 15 YEARS. GIRLS.



INDEX OF SUBSTITUTION. PAGE 4. 15 YEARS.

Section XIII—Completion of Sentences

Table 60. Number of Correct Sentences. 14 years.
Table 61. Number of Correct Sentences. 15 years.
Table 62. Sentence Test. Number of Ideas. 14 years.
Table 63. Sentence Test. Number of Ideas. 15 years.
Table 64. Sentence Test. Index of Ideas. 14 years.
Table 65. Sentence Test. Index of Ideas. 15 years.
Table 66. Sentence Test. Number of sentences with an Association Time of 2 seconds or less. 14 years.
Table 67. Sentence Test. Number of sentences with an Association Time of 2 seconds or less. 15 years.

Materials—A blank containing the beginnings of thirteen sentences, numbered from the bottom up. A piece of cardboard the size of the blank. A stop-watch. (See Whipple's Manual. Test 46 B.)

The number of sentences—thirteen—was the accidental result of the fact that the first supply of blanks for the test was ordered from Stoelting of Chicago from Whipple's copy, and came in the form of two sheets, one containing twelve, and one thirteen sentences, numbered from one to twenty-five. The twenty-five sentences seemed unnecessarily long and fatiguing, and so we used only the first page, which contained thirteen sentences. Several forms were needed because of possible communication. The new forms had to have the same number of sentences as the old. The five forms used are printed below.

	a	b	c
13.	If some one happens	Because	If some child
12.	The star	The story	The theatre
11.	Because	Since	The reason why
10.	If you do not	If you tell	Since
9.	Smile	Run	I told
8.	I hasten	I knew	Think
7.	It was evening	In the morning	It was snowing
6.	A stroke of lightning	An accident	The death of
5.	When you have to	When you see	When you went
4.	The house	The child	The factory
3.	It rains	It seems	It is better
2.	One must have patience	It is never right	One must never
1.	I entered	I heard	The boy went

	d	e
13.	In the evening	It is hard
12.	The newspaper	A strange
11.	I was sorry	Try
10.	Letter writing	He asked me
9.	The funeral of	The child learned
8.	A flash of lightning	I do not like
7.	If	The store
6.	Our dog	This summer
5.	The continuation school	A very good
4.	It is fun	Before
3.	Remember	In the rain
2.	You ought not	Boys often
1.	A year ago	When I

Criticisms—The five forms, like the opposite blanks, are not strictly standardized. In devising the new forms, we tried to make them of equal difficulty, and of equal stimulating power, but there has been no true standardization of the pages. One defect which can easily be seen is that they are unequal in their tendency to call out complex sentences. There are some beginnings—at least one, and not more than three—on each page which cannot be completed without forming a complex sentence, and there are others which may be made simple, but are most naturally completed as complex sentences.

Method of administering the test—The printed sheet, covered by the piece of cardboard, was placed on the table in front of the child. The experimenter was supplied with a piece of paper numbered to correspond with the thirteen sentences to be used for recording association time, and a stop-watch, both screened from the child. The usual method of screening was by holding one-half of the child's folder upright. All suggestion of speed or of timing was carefully avoided in giving this test. The instructions were given as follows:

"On this piece of paper under the cardboard are the beginnings of some sentences. Only the first few words of the sentence are printed on the paper, and what I want you to do is to write something after those words which will complete the sentence. You know what a whole sentence is, don't you? You studied about

that in grammar. You may write anything you wish which makes sense, but be sure that what you write forms a whole sentence, not just part of one. For instance, if you saw the words: 'The horse' on the paper, what could you write after that to make a whole sentence of it? (The answer either approved or criticized.) I will show you these beginnings of sentences one at a time, and you write anything you wish. Here is the first one."

At this point the experimenter with one hand pulled up the cardboard, exposing the first sentence, and with the other started the stop-watch. The experimenter kept his eye on the watch, and noted the number of seconds elapsing between the exposure of the words, and the beginning of the writing, giving a rough measure of the association time for each sentence. No attempt was made to distinguish intervals of less than two seconds. Since the timing and exposing process was rather difficult, each experimenter practised counting seconds as accurately as possible, until he attained some proficiency. In giving the test he counted seconds from the time the sentence was exposed, until he could get his eye on the watch. The longer intervals, therefore,—any longer than three or four seconds—were measured by the watch, while the shorter ones were often merely counted. For this reason fine distinctions of association time are not taken into account. No child was allowed more than 60 seconds to start any sentence. At the end of a pause of that length, he was told to omit that sentence and go on to the next one. The time for the entire test was recorded, as well as the association times for each sentence.

Method of dealing with results—The following measurements of the sentence test were recorded:

1. The number of sentences attempted.

2. The number of correct sentences. In marking correctness, only the form of the sentence was taken into account. A wrong tense, or the wrong form of adjective or adverb, or slang and colloquial phrases did not class the sentence as wrong. Only an error which rendered the result not really a sentence at all, classed it as wrong.

3. The number of simple and of complex sentences. The dis-

tinction in this case was made strictly in accordance with the grammatical rules for complexity.

4. The average number of words used in completing the sentences. Two averages were taken, in cases where one or more sentences were entirely omitted, one based on the entire thirteen sentences, and the other based on the number of sentences completed.

5. The number of ideas. In counting these, the intention was to find out how many distinct ideas—exclusive of repetitions—were expressed on the page. Every noun, every verb other than forms of "to be," all auxiliaries of mood, every adjective, adverb, or personal pronoun, was counted a distinct idea. Personal pronouns when used in the singular and plural were counted both times, though differences of case were not counted. Mere conjunctions, auxiliary verbs of time, prepositions, or relative pronouns referring to words on the page, or modified forms of words already used, were not counted. A mere negation of an expressed idea was not counted. Words which were classed as nonsensical, that is, words which had no evident connection with the beginning of the sentence they were supposed to complete were not counted as ideas. Words which were sensible,—which, while not completing grammatically the printed beginning of the sentence, indicated a distinct idea in the child's mind—were counted. It was found almost impossible for any two people to agree absolutely on a set of rules for marking ideas. After trying it for some time, and finding differences of judgment which it seemed impossible to guard against, we decided to leave all this marking to one person. Accordingly, Mrs. Fischer, who was the final authority on all matters of evaluation, marked every sentence page for ideas.

6. The total time of the test was recorded in seconds.

7. The association times for the sentences were summed up in groups. The first group comprised all the sentences begun in two seconds or less; the second group included all those begun in three to five seconds, inclusive; the third group those begun in six to ten seconds inclusive; the fourth group those begun in eleven to twenty seconds inclusive; and the fifth group those

begun in twenty-one to sixty seconds. Since there were so few long association times, these divisions seemed fine enough.

8. An index of ideas was calculated which consisted of the total time of the test, divided by the number of ideas. In other words, the index represents the average time per idea expressed.

Since the various factors of the sentence test which were evaluated had comparatively little relationship, it will be best to discuss the results for each one separately. Not all of the recorded measures were summarized.

Correctness of Sentences—

Table 60. Number of Correct Sentences. 14 years.

Table 61. Number of Correct Sentences. 15 years.

RESULTS

Age	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	9.2	10.8	9.4	10.7
50 perc.	10.9	12.0	11.1	11.8
75 perc.	13.0	13.5[2]	12.9	13.5[2]
Q	1.9	1.3	1.7	1.4
Limits—				
Lower	4.	6.	5.	5.
Upper	13.	13.	13.	13.

Number of Correct Sentences out of thirteen

[1] One complete failure—only 1 correct.

[2] The percentiles were estimated as though 1 included measures up to 2, etc. Hence 13 includes values up to 14, for purpose of comparison.

Correlation wtih School Grade.

Graph 60a. Number of Correct Sentences. Boys, 14 years.

Graph 60b. Number of Correct Sentences. Girls, 14 years.

Graph 61a. Number of Correct Sentences. Boys, 15 years.

Graph 61b. Number of Correct Sentences. Girls, 15 years.

The correlation with school grade with reference to the number of correct sentences, is perfect for both boys and girls, at both ages.

Comparison of Sex and School.

Graph 60c. Number of Correct Sentences. 14 years.

Graph 61c. Number of Correct Sentences. 15 years.

Sex—Both the percentiles and the graphs show the boys somewhat superior to the girls in the correctness of their sentences at both ages. The difference is more marked at fourteen than at fifteen.

School—The public school children are a little superior to those of the parochial school in the correctness of their sentences. The difference is not large, and is less at fifteen than at fourteen years.

Age—There is a decided improvement in the correctness of the sentences from fourteen to fifteen. The girls gain more in correctness than the boys. The parochial school group gain more than the public school. Most of the children, except the eighth grade group, had been attending a public continuation school during the year where English was one of the subjects emphasized. It is possible that mere familiarity with the form of the test is also a factor in the result.

Number of ideas expressed in the Sentence Test.

Table 62. Number of Ideas. 14 years.

Table 63. Number of Ideas. 15 years.

RESULTS

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	13.5	17.5	14.2	17.7
50 perc.	16.8	22.1	17.5	22.7
75 perc.	21.5	27.1	27.1	27.3
Q	4.0	4.8	3.75	4.8
Limits—				
Lower	6.0	7.0	7.0[1]	8.0
Upper	59.0	59.0	39.0	46.0

Number of ideas, percentiles and limits

[1] One complete failure.

Correlation with School Grade.

Graph 62a. Number of Ideas. Boys, 14 years.

Graph 62b. Number of Ideas. Girls, 14 years.

Graph 63a. Number of Ideas. Boys, 15 years.

Graph 63b. Number of Ideas. Girls, 15 years.

There is a positive correlation with school grade in the number of ideas expressed for both sexes, and at both ages. The correlation is more decided and more perfect at fourteen than at fifteen.

Comparison of Sex and School.

Graph 62c. Number of Ideas, 14 years.

Graph 63c. Number of Ideas, 15 years.

Sex—There is so small a difference of sex with reference to the number of ideas expressed, that it can scarcely be considered significant. The percentiles and the fourteen-year graphs show a very slight superiority of the girls, but one could not be certain of any sex difference in the fifteen-year graphs.

School—At fourteen the graphs show no difference of school alone. The public school boys are better than the parochial school boys, while the parochial school girls are better than the public school girls. At fifteen there is an advantage on the side of the public school group, though the same general relation of the four groups holds.

Age—There is a large increase in the number of ideas expressed at fifteen years. It amounts to an average of about five ideas per page for both sexes. The public school group gains a little more than the parochial.

Index of Ideas.

Table 64.—Index of Ideas. 14 years.

Table 65.—Index of Ideas. 15 years.

RESULTS

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	8.8	8.3	8.3	8.1
50 perc.	11.1	10.5	10.7	10.2
75 perc.	14.7	14.1	14.0	14.7
Q	2.9	2.9	2.8	3.3
Limits—				
Lower	4.7	4.3	4.9	4.2
Upper	106.0	99.4	42.0[1]	90.0

Index of ideas (number of seconds per idea expressed). Percentiles and limits

[1] One complete failure.

Correlation with School Grade.

Graph 64a—Index of Ideas. Boys, 14 years.

Graph 64b—Index of Ideas. Girls, 14 years.

Graph 65a—Index of Ideas. Boys, 15 years.

Graph 65b. Index of Ideas. Girls, 15 years.

There is a positive correlation with school grade in the index of ideas for both sexes, and at both ages. The only irregularity in any graph is that at fifteen years, the fifth grade group of girls is better than the sixth. The correlation is more marked here throughout than it was in the case of the number of ideas expressed. That is, the children in the upper grades not only express a greater number of ideas, but do so in a shorter time.

Comparison of Sex and School.

Graph 64c—Index of Ideas, 14 years.

Graph 65c—Index of Ideas, 15 years.

Sex—Both the percentiles, and the graphs show a somewhat larger proportion of girls with a low index. The sex difference is small both years. Since there is practically no sex difference in the number of ideas expressed, the girls gain their advantage in the index from their greater speed.

School—The public school group, shows a lower index at both ages than the parochial school. Taken in connection with the results for the number of ideas expressed, this means that at fourteen years the lower index of the public school group means greater speed only. At fifteen, the difference is partly due to a greater number of ideas expressed.

Age—There is a small decrease in the index from fourteen to fifteen. While the number of ideas expressed at fifteen is much larger than at fourteen, the average time required to express an idea is only slightly less at fifteen.

Number of Sentences with an Association Time of 2 Seconds or Less.

Table 66—14 years. Table 67—15 years.

RESULTS

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	2.1	2.2	2.2	1.4
50 perc.	4.8	5.7	4.7	4.9
75 perc.	8.7	8.7	7.6	7.9

Number of sentences begun in two seconds or less. Percentiles. (The limits are, of course, 0 and 13, in each case)

Correlation with School Grade—

Graph 66a—Association Time. Boys, 14 years.

Graph 66b—Association Time. Girls, 14 years.

Graph 67a—Association Time. Boys, 15 years.

Graph 67b—Association Time. Girls, 15 years.

There is a large positive correlation with school grade in association time. The graphs are expressed in terms of the proportion of the groups which began a given number of the sentences in two seconds or less. In the case of the fifth grade, for instance, the graphs show that a very large proportion of them began only three or less sentences in as short a time as two seconds. The association time for the other ten or more sentences must have been longer. The higher the proportion at the lower end of the graph then, the slower the group. In every graph for both sexes and at both ages, the short association times predominate in the upper grades and vice versa. The only exception to a perfect grade correlation is in the graph for fifteen-year old girls, where the sixth grade group is poorer than the fifth.

Comparison of Sex and School—

Graph 66c—Association Time. 14 years.

Graph 67c—Association Time. 15 years.

Sex—Though the sex difference is small, one can say that the girls have slightly longer association times than the boys. The percentiles show a difference at both ages, though it is greater at fifteen than at fourteen. The graphs show no difference of sex at fourteen, at fifteen the girls are slower, but the difference is due to the parochial school group.

School—The parochial school group have longer association times (i.e. are slower in beginning their sentences) at both ages.

Age—The fifteen-year old group show a slight decrease in association time as compared with the fourteen-year group. The boys have reduced the time somewhat more than the girls.

TABLE 60
Number of Correct Sentences. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
PUBLIC SCHOOL	No of sentences	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
	7—	1	1.2	0		0		0				0		0		0		0			
	7	9	10.7	2	3.0	0		0				1	2.4	0		1	2.4	0	1		3.7
	8	6	7.1	3	4.5	1	2.3	0				1	2.4	9	15.3	2	4.9	1			3.7
	9	11	13.1	3	4.5	2	4.6	1			4.2	8	19.0	5	8.5	5	12.2	0			0.0
	10	17	20.2	12	17.9	5	11.6	1			4.2	7	16.7	8	13.6	6	14.6	1	1		7.4
	11	15	17.8	13	19.4	7	16.3	3			12.5	9	21.4	10	17.0	8	19.5	4			14.8
	12	14	16.7	20	29.9	9	20.9	4	1		20.8	12	28.6	14	23.7	11	26.8	9	1		37.0
	13	11	13.1	14	20.9	19	44.2	13	1		58.3	4	9.5	13	22.0	8	19.5	9			33.3
	Total	84		67		43		22	2			42		59		41		24	3		
	Omitted	2		1		0		0	0			1		0		2		0	0		
PAROCHIAL SCHOOL	7—	3	8.1	1	1.7	0		1			2.6	2	8.0	0		1	1,8	0			
	7	2	5.4	4	6.8	0		0				0	0.0	1	2.3	2	3.6	0			
	8	7	18.9	3	5.1	2	3.1	1			2.6	5	20.0	5	11.6	1	1.8	1	1		6.1
	9	5	13.5	10	17.0	10	15.6	4			10.2	2	8.0	5	11.6	2	3.6	1			3.0
	10	4	10.8	7	11.9	7	10.9	2	1		7.7	5	20.0	5	11.6	11	20.0	4	1		15.1
	11	7	18.9	6	10.2	10	15.6	5	1		15.4	0	0.0	6	13.9	4	7.3	3			9.1
	12	6	16.2	10	17.0	20	31.3	9			23.1	9	36.0	10	23.3	14	25.4	12			36.4
	13	3	8.1	18	30.5	15	23.5	14	1		38.5	2	8.0	11	25.6	20	36.4	9	1		30.3
	Total	37		59		64		36	3			25		43		55		30			
	Omitted	1		0		1		1	0			1		0		0		1			

TABLE 61
Number of Correct Sentences. 15 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
PUBLIC SCHOOL	No of sentences	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
	7—	2	2.7	0	0.0	0	0.0	0				0		0	0.	0	0.	0		0.	
	7	0	0.0	1	1.7	1	2.7	0				1	3.0	1	2.	1	2.9	0		0.	
	8	2	2.7	2	3.5	0	0.0	0				4	12.1	0	0.	4	11.8	0		0.	
	9	4	5.3	4	7.1	1	2.7	0				2	6.1	2	4.	3	8.8	0		0.	
	10	5	6.7	3	5.3	1	2.7	0				3	9.1	3	6.	0	0.	2		10.5	
	11	11	14.6	3	5.3	1	2.7	2		8.3		0	0.0	8	16.	4	11.8	1		5.3	
	12	25	33.3	14	24.5	9	24.3	4	1	20.8		10	30.3	16	32.	7	20.6	3	1	21.0	
	13	26	34.7	30	52.6	24	64.9	16	1	70.8		13	39.4	20	40.	15	44.1	12		63.2	
	Total	75		57		37		22	2			33		50		34		18	1		
	Omitted	5		5		6						3		3		2		2			
PAROCHIAL SCHOOL	7—	1	3.2	0	0	1	1.7	0				2	8.7	0	0.	1	2.0	0		0.	
	7	0	0.0	0	0	0	0.0	0				0	0.	1	2.9	0	0.0	0		0.	
	8	3	9.7	0	0	1	1.7	0				1	4.3	1	2.9	2	4.1	1		5.	
	9	3	9.7	3	5.9	0	0.0	0				1	4.3	2	5.7	3	6.1	1		5.	
	10	5	16.1	6	11.8	6	10.2	1		3.2		3	13.0	3	8.6	1	2.0	0		0.	
	11	6	19.4	10	19.6	6	10.2	5		16.1		2	8.7	6	17.1	5	10.2	0		0.	
	12	5	16.1	7	13.7	11	18.6	6		19.4		5	21.7	9	25.7	13	26.5	5		25.	
	13	8	25.8	25	49.0	34	57.6	19		61.3		9	39.1	13	37.1	24	49.0	10	3	65.	
	Total	31		51		59		31				23		35		49		17	3		
	Omitted	4		2		3		2				1		2		2		9			

TABLE 62

Sentence Test. Number of Ideas. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	No. of Ideas	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	12—	9		4		1		0				2		5		3		0			
	12	8	20.2	5	13.5	2	6.9	1		4.2		6	19.1	7	20.4	1	9.7	1		3.7	
	13-14	11		14		3		1				2		4		7		3	2		
	15-16	9	23.8	15	43.3	8	25.6	4		20.9		9	26.2	10	23.8	7	34.2	3	1	33.3	
	17-18	11		6		6		3				7		11		6		2			
	19-20	9	23.8	4	14.9	3	20.9	4	1	33.3		6	31.0	10	35.6	5	26.8	4		22.2	
	21-22	6		6		6		2				2		3		2		3			
	23-24	9	17.8	5	16.4	2	18.5	2		16.6		2	9.6	3	10.2	2	9.8	2		18.5	
	25-26	6		4		7		1	1			1		3		7		0			
	27-28	0	7.1	1	7.5	3	23.3	1		12.5		3	9.5	0	5.1		17.1	3		11.1	
	29-30	3		2		0		2				0		1				1			
	31-32	2	6.0	1	4.5	1	2.3	1		12.5		1	2.4	1	3.4		0.0	1		7.4	
	33-34	1										0									
	35-36		1.2									1	2.4		0.0	1	2.4			0.0	
	37-38																				
	39-40													1				1			
	41-42																				
	43-44					1															
	44+						2.3								1.7					3.7	
	Total	84		67		43		22	2			42		25		41		24	3		
	Omitted	2		1		0		0	0			1		1		2		0	0		
Parochial School	12—	8		7		0		2				4		4		4		1			
	12	6	36.8	2	15.3	2	3.1	3		12.8		2	24.0	3	16.3	3	12.7	1		6.1	
	13-14	7		13		7		4				3		6		1		1	1		
	15-16	9	42.1	8	35.6	11	28.1	2	1	17.9		5	32.0	7	30.2	6	12.7	4		18.2	
	17-18	3		7		15		4				3		2		7		6	2		
	19-20	3	15.8	4	18.7	8	36.0	4		20.5		2	20.0	7	20.9	8	27.2	5		39.4	
	21-22	1		6		9		7				1		3		8		4			
	23-24	1	5.2	3	15.3	6	23.4	3	1	28.2		1	8.0	2	11.6	5	23.6	1		15.2	
	25-26			3		0		2	1			3		7		4		0			
	27-28			1	6.8	0	0.0	2		12.8			12.0	0	16.3	5	16.4	5		15.2	
	29-30			4		3		1						1		3		1			
	31-32				6.8	2	7.8	1		5.1		1	4.0	0	2.3	0	5.4	0		3.0	
	33-34					1		0						0		0		0			
	35-36				0.0		1.6	1		2.5				1	2.3	1	1.8	1		3.0	
	37-38			1																	
	39-40																				
	41-42																				
	43-44																				
	44+				1.7																
	Total	38		59		64		36	3			25		43		55		30	3		
	Omitted	0		0		1		1	0			1		0		0		1	0		

TABLE 63

Sentence Test. Number of Ideas. 15 years

School	Grade	Boys V No.	Boys V %	Boys VI No.	Boys VI %	Boys VII No.	Boys VII %	Boys VIII	Boys IX	Boys VIII and IX %	Girls V No.	Girls V %	Girls VI No.	Girls VI %	Girls VII No.	Girls VII %	Girls VIII	Girls IX	Girls VIII and IX %
PUBLIC SCHOOL	No. of Ideas																		
	12—	4		1		1		0	0		1		2		3		0		
	12	0	5.3	0	1.7	0	2.7	0	0	0.0	0	3.0	0	4.	0	8.8	0		
	13-14	4		6		2		0	0		2		2		2		1		
	15-16	4	10.5	6	21.0	0	5.4	1	0	4.2	5	21.2	0	4.	4	17.6	2		15.8
	17-18	6		4		2		3	0		3		6		3		0	1	
	19-20	6	15.8	5	15.8	2	10.8	2	1	25.0	3	18.2	7	26.	5	23.5	2		15.8
	21-22	9		9		5		2			2		3		4		3		
	23-24	8	22.4	6	26.3	6	29.7	5		29.2	2	12.1	5	16.	4	23.5	3		31.6
	25-26	12		3		5		2			7		4		5		2		
	27-28	11	30.3	4	12.3	2	18.9	2		16.7	4	33.3	4	16.	2	20.6	3		26.3
	29-30	1		4		3		1			1		7		0		0		
	31-32	4	6.6	5	15.8	2	13.5	1		8.3	0	3.0	4	22.	1	2.9	2		10.5
	33-34	3		1		3		2	1		1		1		0				
	35-36	1	5.2	0	1.7	1	10.8	1		16.7	1	6.1	1	4.	0				
	37-38	0		1		1					0		1		0				
	39-40	0	0.0	1	3.5	1	5.4				1	3.0	1	4.	1	2.9			
	41-42	2		1		0							2						
	43-44 44+	1	3.9		1.7	1	2.7							4.					
	Total	76		57		37		22	2		33		50		34		18	1	
	Omitted	4		5		6					3		3		2		2		
PAROCHIAL SCHOOL	12—	5		1		2		0			2		1		1		1		
	12	0	16.1	0	1.9	0	3.4	0		0.0	0	8.7	0	2.9	0	2.0	0		5.3
	13-14	3		6		0		3			1		3		2		0		
	15-16	2	16.1	3	17.6	9	15.5	2		16.1	2	13.0	3	17.1	2	8.2	1		5.3
	17-18	6		5		7		1			6		1		4		2		
	19-20	5	35.5	3	15.7	8	25.9	5		19.4	1	30.4	4	14.3	6	20.4	0		10.5
	21-22	4		6		7		3			3		2		3		1		
	23-24	3	22.6	4	19.6	10	29.3	2		16.1	2	21.7	5	20.0	6	18.4	2	1	21.0
	25-26	0		5		3		3			0		5		6		1	0	
	27-28	0	00.0	4	17.6	3	10.3	4		22.6	3	13.0	4	25.7	7	26.5	1	0	10.5
	29-30	0		7		1		4			1		4		2		2	1	
	31-32	2	6.4	4	21.6	0	1.7	1		16.1	1	8.7	2	17.1	4	12.2	1	0	21.0
	33-34	0		1		3		1			0		0		2		2	0	
	35-36	1	3.2	0	1.9	2	8.6	1		6.4	1	4.3	1	2.9	2	8.2	1	0	15.8
	37-38			0		1		0							0		0	0	
	39-40			1	1.9	2	5.2	0		0.0					1	2.0	0	0	0.0
	41-42			0				0							1		0	0	
	43-44 44+	1	1.9			1		3.2								2.0	1	1	10.5
	Total	31		51		58		31			23		35		49		16	3	
	Omitted	4		2		4		2					2		2		10		

TABLE 64

Sentence Test. Index of Ideas. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
		No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	Seconds	2		3		2		2				1		3		2		4			
	5 - 6.5	8	12.5	10	20.0	10	29.3	9		45.8		6	16.7	11	23.7	7	22.0	12		59.2	
	6.6- 8.5	16		19		14		6				4		11		13		4	2		
	8.6-10.5	14	37.5	9	43.0	10	58.5	1	1	33.3		11	35.7	10	35.6	6	46.3	2		29.6	
	10.6-12.5	15		10		4		2				11		10		4		1			
	12.6-14.5	8	28.7	2	18.5	1	12.1	1	1	16.6		4	35.7	2	20.4	4	19.4			3.7	
	14.6-16.5	4		5				1				2		7		2			1		
	16.6-18.5	1	6.2	3	12.3					4.2		2	9.6	1	13.6	0	4.9	1		7.4	
	18.6-20.5	6		2								1		2		2					
	20.6-24.5	2	10.0	2	6.2								2.4	0	3.4	0	4.9				
	24.6-28.5	2												1		1					
	28.6-32.5	2	5.0											1	3.4		2.4				
	32.5+	80		65		41		22	2			42		59		41		24	3		
	Total	6		3		2		0	0			1		0		2		0	0		
	Omitted																				
Parochial School	5 - 6.5	0		1		5		2				0		0		3		3			
	6.6- 8.5	1	2.7	6	12.9	13	29.1	8	1	29.0		1	4.2	8	20.0	18	38.8	4	2	28.1	
	8.6-10.5	4		16		11		13	1			3		11		7		13	1		
	10.6-12.5	5	24.3	9	46.3	8	30.6	3		44.7		6	37.5	4	37.5	9	29.7	5		59.3	
	12.6-14.5	5		5		10		4				3		6		5		3			
	14.6-16.5	1	16.2	6	20.4	4	22.5	3		18.4		3	25.0	4	25.0	6	20.4	0		9.4	
	16.6-18.5	7		3		6		1	1			3		2		1		1			
	18.6-20.5	3	27.0	1	7.3	0	9.7			5.3		1	16.7	3	12.5	1	3.6			3.1	
	20.6-24.5	3		2		1						0		1		1					
	24.6-28.5	2	13.5	3	9.2	4	8.0			0.0		1	4.2	0	2.5	0	3.6				
	28.6-32.5	3		1								1		1		2					
	32.5+	3	16.2	1	3.6			1		2.6		2	12.5		2.5	1	5.5				
	Total	37		54		62		35	3			24		40		54		29	3		
	Omitted	1		5		3		2	0			2		3		1		2	0		

TABLE 65

Sentence Test. Index of Ideas. 15 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX		VIII and IX	V		VI		VII		VIII	IX		VIII and IX
	Seconds	No.	%	No.	%	No.	%	No.	No.		%	No.	%	No.	%	No.	%	No.	No.		%
Public School	5. - 6.5	3		6		1		6	1			1		1		1		4			
	6.6- 8.5	7	13.7	13	33.3	12	35.1	5			50	6	21.9	9	20.4	9	29.4	7			61.1
	8.6-10.5	13		9		14		8				6		10		9		3			
	10.6-12.5	18	42.5	10	33.3	4	48.7	2			41.7	5	34.4	4	28.6	7	47.1	2	1		33.3
	12.6-14.5	12		6		1		0				3		6		1		0			
	14.6-16.5	6	24.7	3	15.8	3	10.8	0	1		4.2	3	18.7	5	22.4	2	8.8	1			5.6
	16.6-18.5	2		1		0		1				1		8		2					
	18.6-20.5	3	6.8	2	5.3	2	5.4				4.2	4	15.6	1	18.4	0	5.9				
	20.6-24.5	4		4		0						1		4		2					
	24.6-28.5	2	8.2	0	7.1	0						1	6.2	1	10.2	0	5.9				
	28.6-32.5	1		1		0						1		0		0					
	32.5+	2	4.1	2	5.3	0						0	3.1	0		1	2.9				
	Total	73		57		37		22	2			32		49		34		17	1		
	Omitted	7		5		6						4		4		2		3			
Parochial School	5. - 6.5	1		2		5		2				1		2		6		2	1		
	6.6- 8.5	1	6.4	9	22.	13	32.1	8			32.3	4	21.7	6	22.9	9	31.2	6	1		55.6
	8.6-10.5	7		13		14		8				7		7		17		2	1		
	10.6-12.5	3	32.3	9	44.	6	35.7	6			45.2	2	39.1	6	37.1	6	47.9	0			16.7
	12.6-14.5	6		4		6		3				2		3		3		2			
	14.6-16.5	3	29.0	4	16.	3	16.1	0			9.7	0	8.7	3	17.1	4	14.6	2			22.2
	16.6-18.5	0		2		3		1				3		3		0					
	18.6-20.5	2	6.4	3	10.	3	10.7	0			3.2	0	13.0	2	14.3	0	0.0				
	20.6-24.5	6		1		2		3				1		1		1					
	24.6-28.5	0	19.4	2	6.	1	5.3	0			9.7	0	4.3	0	2.9	0	2.1				
	28.6-32.5	1		1		0		0				2		1		1		1			
	32.5+	1	6.4	0	2.	0		0				1	13.0	1	5.7	1	4.2	0			5.6
	Total	31		50		56		31				23		35		48		15	3		
	Omitted	4		3		6		2				1		2		3		11			

TABLE 66

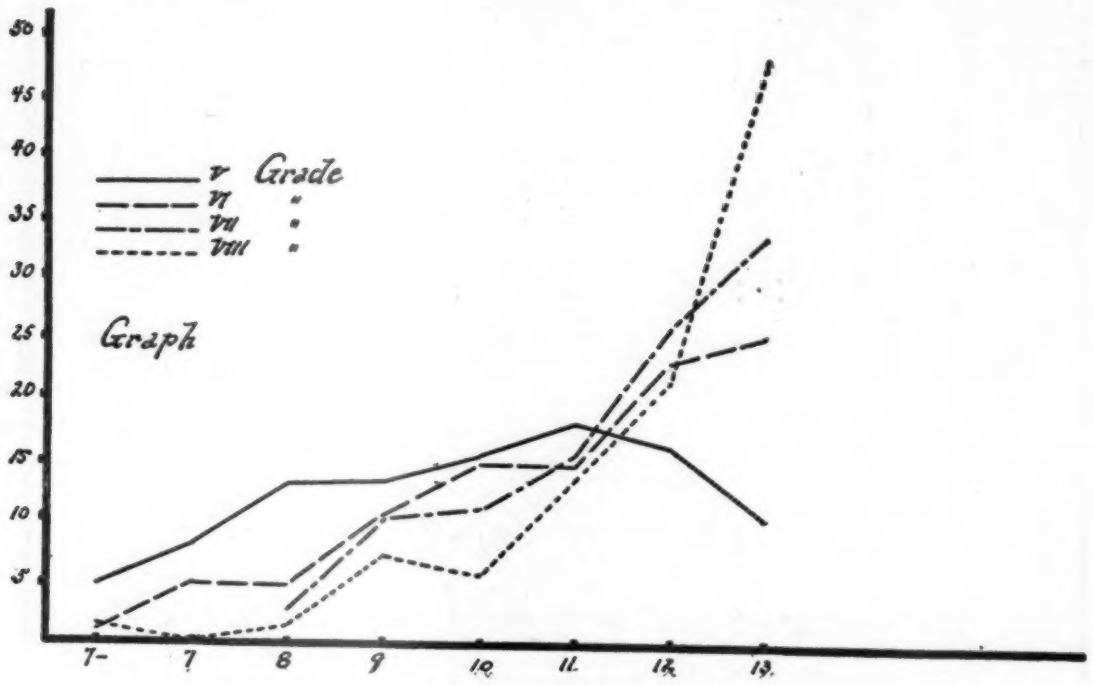
Sentence Test. Number of Sentences with an Association Time of 2 seconds or Less. 14 years

School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX		VIII and IX	V		VI		VII		VIII	IX		VIII and IX
	No. of sentences	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	0- 1	13		3		1		3				4		5		6		2	1		
	2- 3	23	42.9	15	27.7	2	7.5	3	2		34.7	11	35.7	15	33.9	5	27.5	3			22.2
	4- 5	13		13		10		1				9		17		9		2			
	6- 7	16	34.5	12	38.5	13	57.5	5			26.0	8	40.4	6	39.0	7	40.0	4	1		25.9
	8- 9	14	—	11	-	7		2				5		9		10		7	1		
	10-11	4	21.5	7	27.7	4	27.5	5			30.4	2	16.7	5	23.8	2	30.0	5			48.1
	12-13	1	1.2	4	6.1	3	7.5	2			8.7	3	7.1	2	3.4	1	2.5	1			3.7
	Total	84		65		40		21	2			42		59		40		24	3		
	Omitted	2		3		3		1	0			1		0		3		0	0		
Parochial School	0- 1	10		8		8		2				7		10		7		4			
	2- 3	11	56.7	16	42.1	18	41.9	4			15.3	7	56.0	6	37.2	6	23.6	5			27.2
	4- 5	6		11		4		9	2			7		7		13		4	1		
	6- 7	5	29.7	9	35.1	9	20.9	8			48.7	2	36.0	9	37.2	8	38.1	7			36.3
	8- 9	4		10		9		2				1		6		10		8	1		
	10-11	1	13.5	3	22.8	10	30.6	6			20.5	1	8.0	3	20.9	8	32.7	0	1		30.3
	12-13	0	0.0	0		4	6.4	5	1		15.4	0		2	4.6	3	5.4	2			6.1
	Total	37		57		62		36	3			25		43		55		30	3		
	Omitted	1		2		3		1	0			1		0		0		1	0		

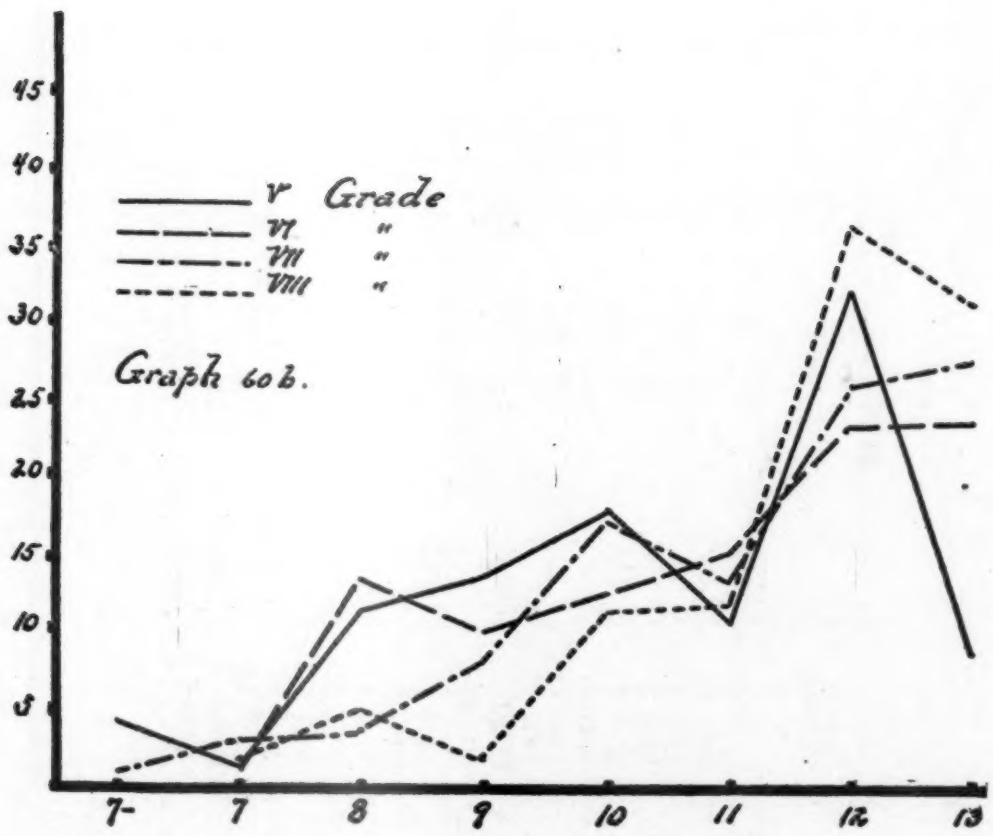
TABLE 67

Sentence Test. Number of Sentences with an Association Time of 2 seconds or less. 15 years

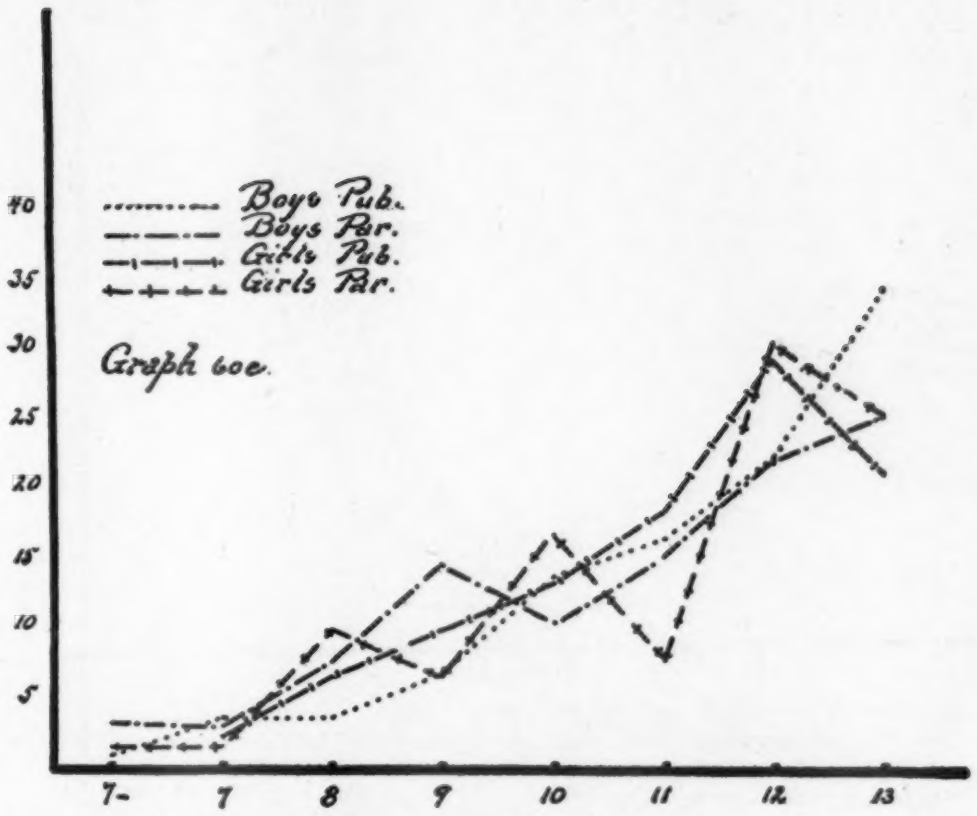
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
PUBLIC SCHOOL	No. of sentences	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
	0 and 1	17		6		3		2				8		12		3		2			
	2 and 3	12	38.2	10	28.1	6	24.3	1		12.5		4	36.4	9	42.	7	29.4	1		17.6	
	4 and 5	10		3		9		3				6		6		3		0			
	6 and 7	14	31.6	12	26.3	7	43.2	2	2	29.2		3	27.3	12	36.	6	26.5	3		17.6	
	8 and 9	11		12		4		5				6		5		8		5			
	10 and 11	7	23.7	8	35.1	5	24.3	5		41.7		4	30.3	3	16.	4	35.3	4		52.9	
	12 and 13	5	6.6	6	10.5	3	8.1	4		16.7		2	6.0	3	6.	3	8.8	2		11.8	
	Total	76		57		37		22	2			33		50		34		17	0		
	Omitted	4		5		6						3		3		2		3	1		
PAROCHIAL SCHOOL	0 and 1	9		9		12		2				5		13		8		4			
	2 and 3	6	46.9	7	31.4	7	32.2	4		19.4		6	47.8	3	45.7	15	47.9	2	1	44.6	
	4 and 5	4		7		5		6				2		5		4		2			
	6 and 7	6	31.2	10	33.3	5	16.9	5		35.5		3	21.7	7	34.3	7	22.9	2	1	26.3	
	8 and 9	4		8		11		7				4		4		6		3			
	10 and 11	3	21.9	8	31.4	13	40.7	3		32.3		2	26.1	1	14.3	1	14.6	2	1	21.6	
	12 and 13	0		2	3.9	6	10.2	4		12.9		1	4.3	2	5.7	7	14.6	1		7.5	
	Total	32		51		59		31				23		35		48		16	3		
	Omitted	3		2		3		2				1		2		3		10			



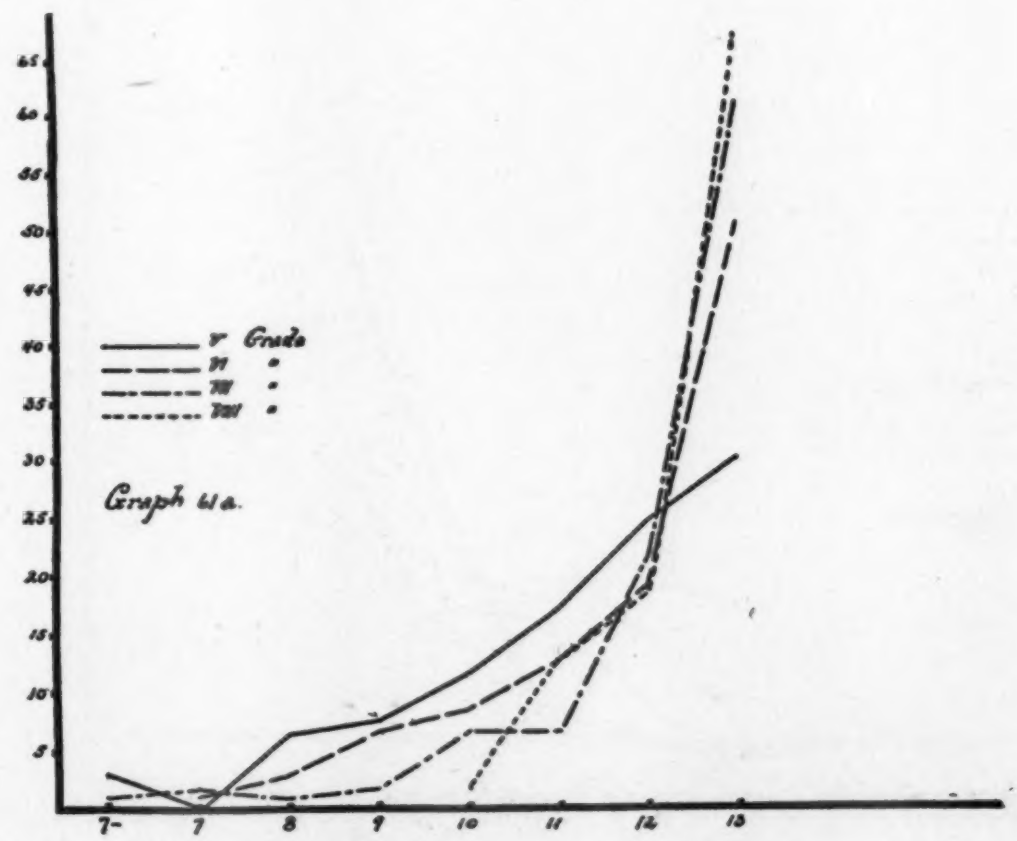
NUMBER OF CORRECT SENTENCES. 14 YEARS. BOYS.



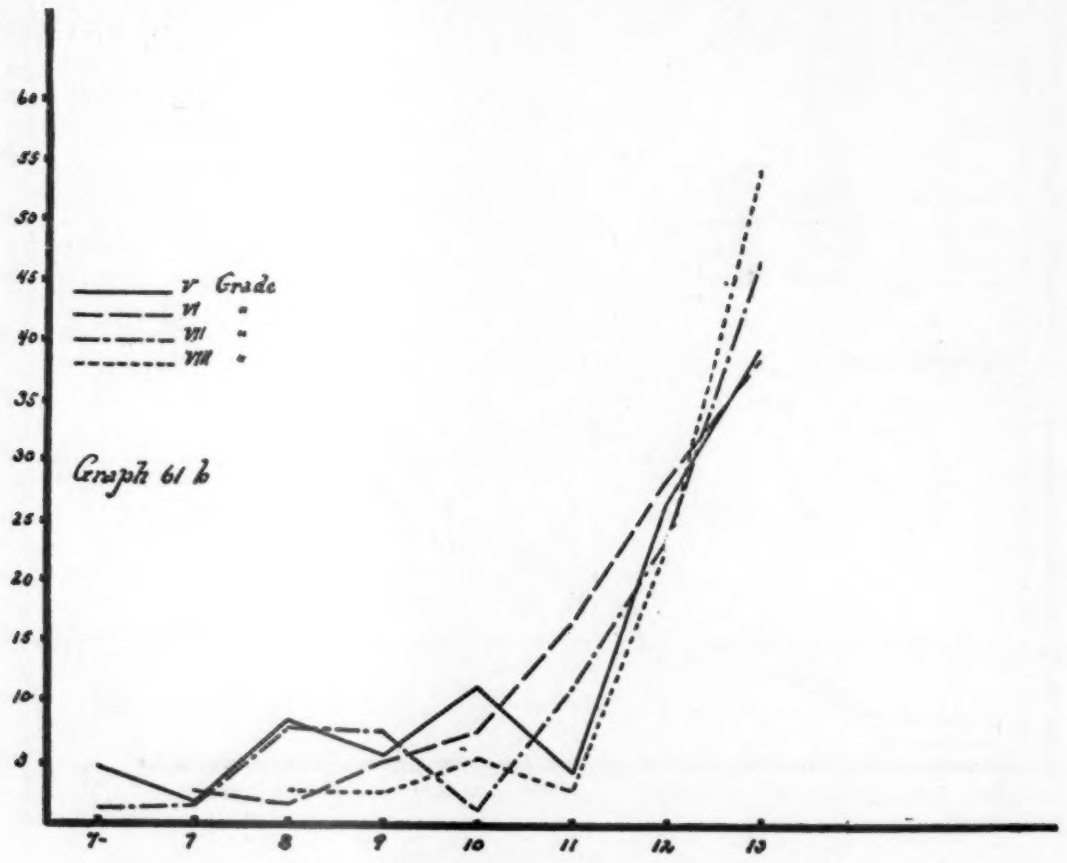
NUMBER OF CORRECT SENTENCES. 14 YEARS. GIRLS.



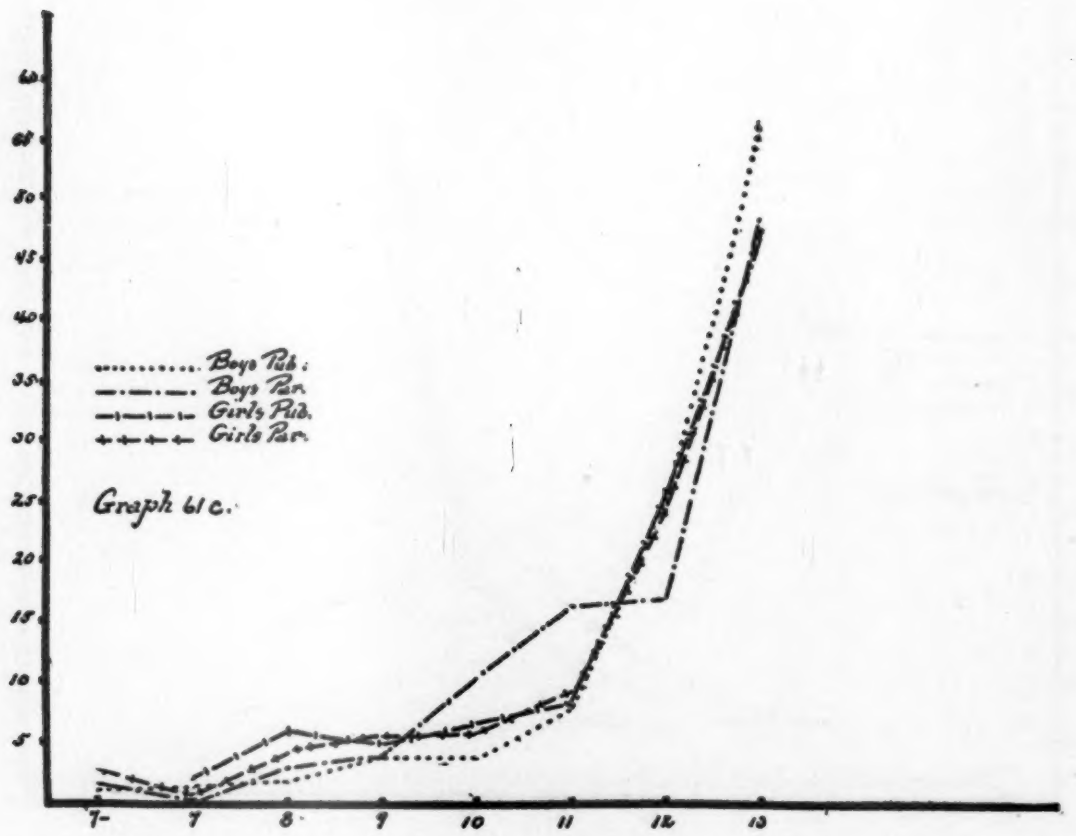
NUMBER OF CORRECT SENTENCES. 14 YEARS.



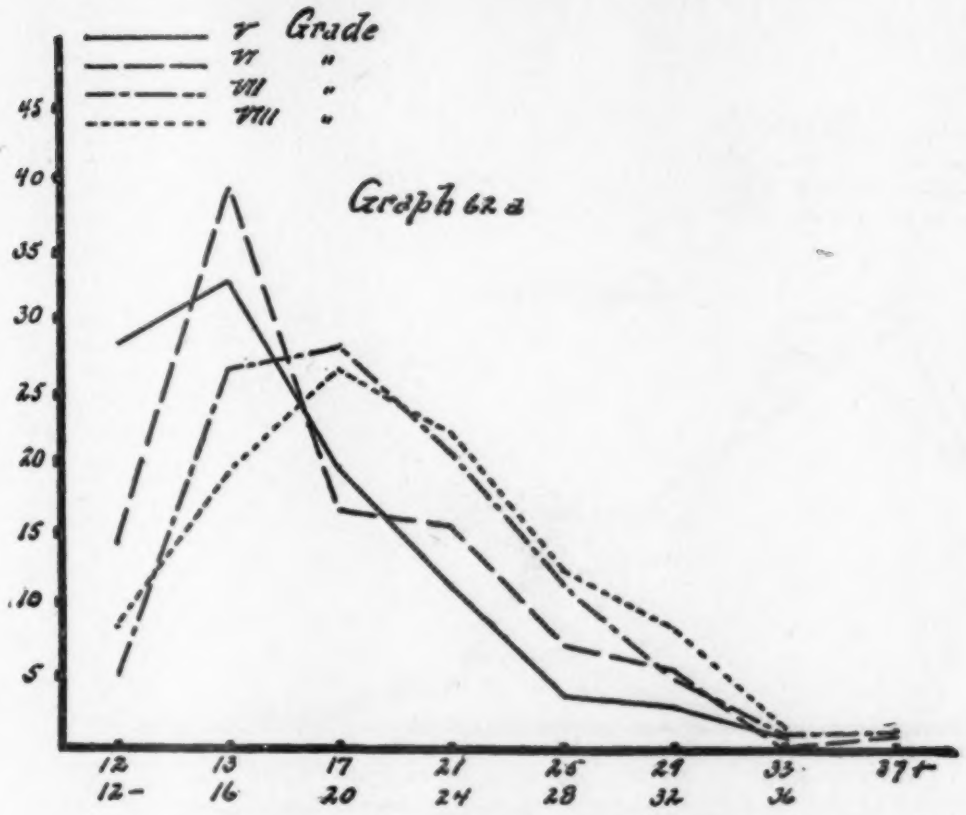
NUMBER OF CORRECT SENTENCES. 15 YEARS. BOYS.



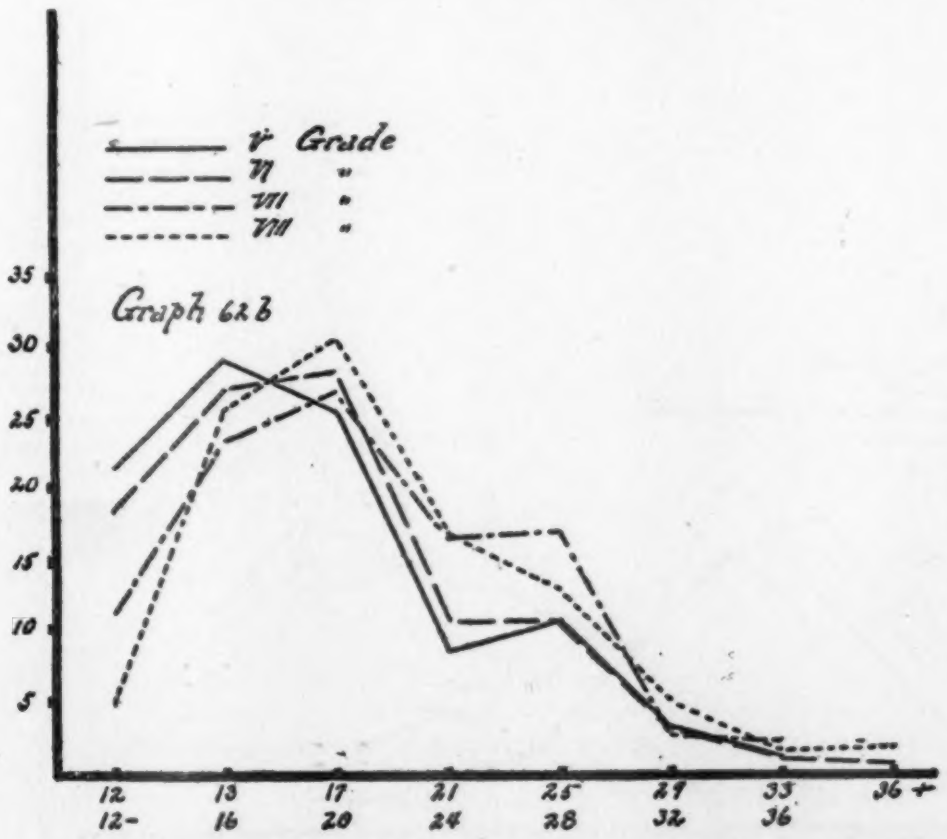
NUMBER OF CORRECT SENTENCES. 15 YEARS. GIRLS.



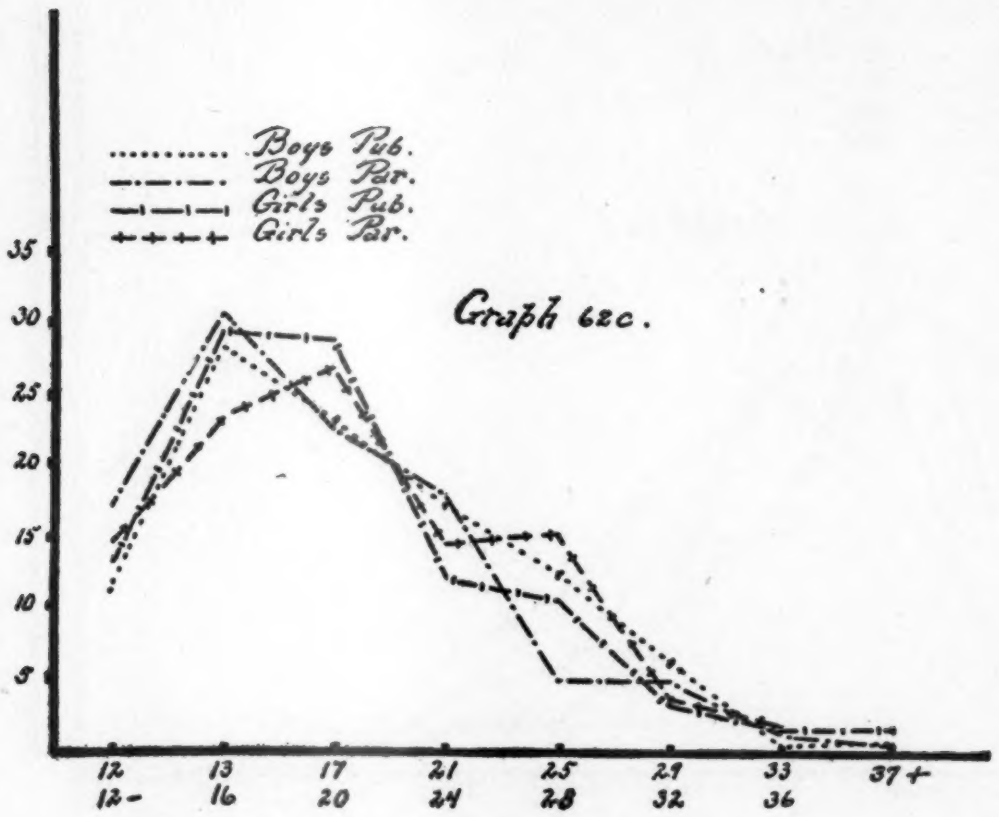
NUMBER OF CORRECT SENTENCES. 15 YEARS.



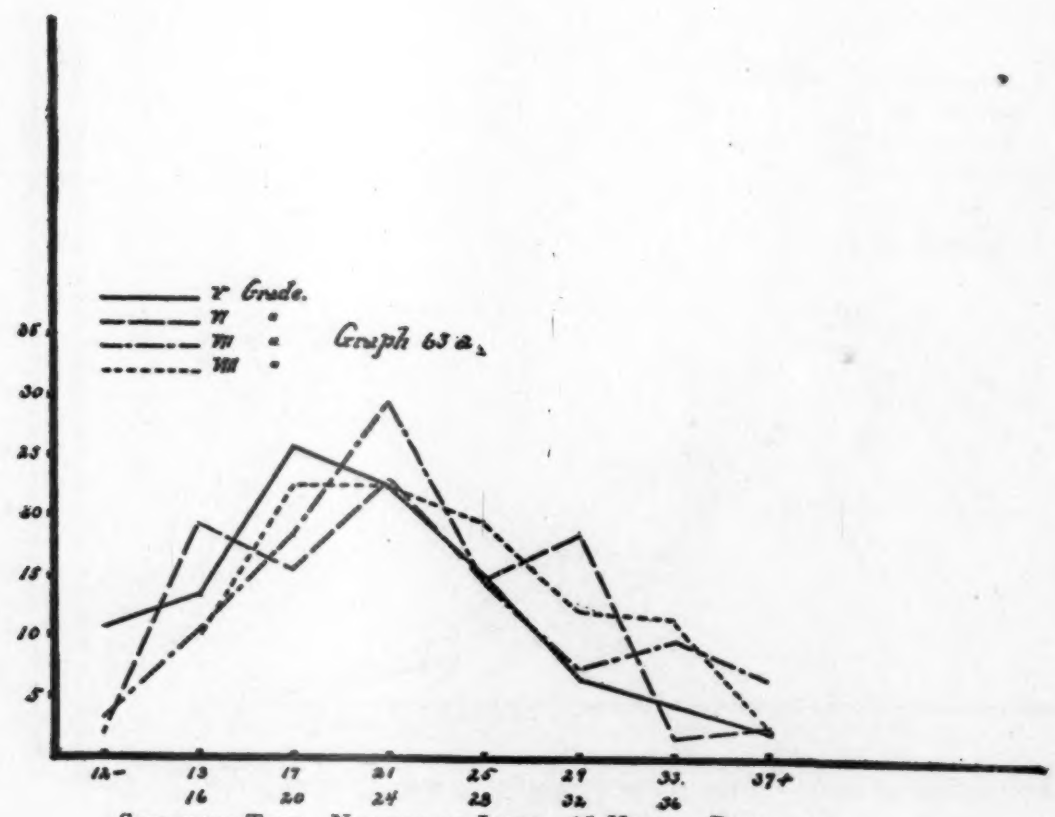
SENTENCE TEST. NUMBER OF IDEAS. 14 YEARS. BOYS.



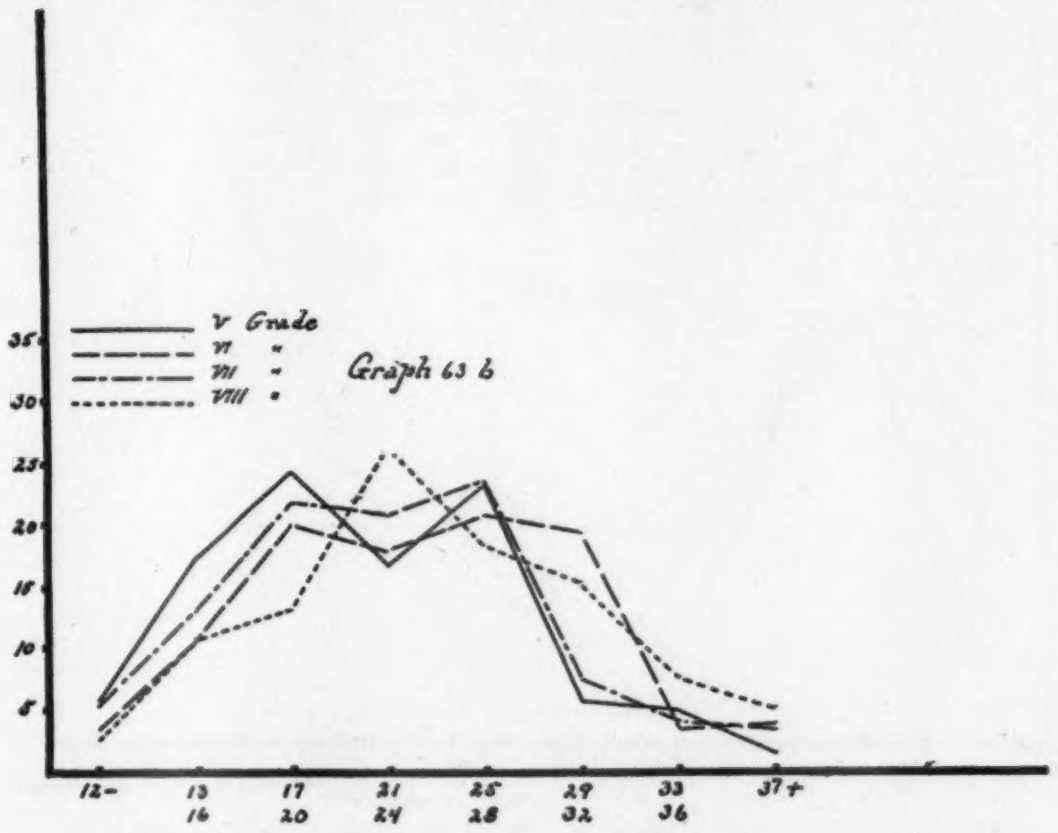
SENTENCE TEST. NUMBER OF IDEAS. 14 YEARS. GIRLS.



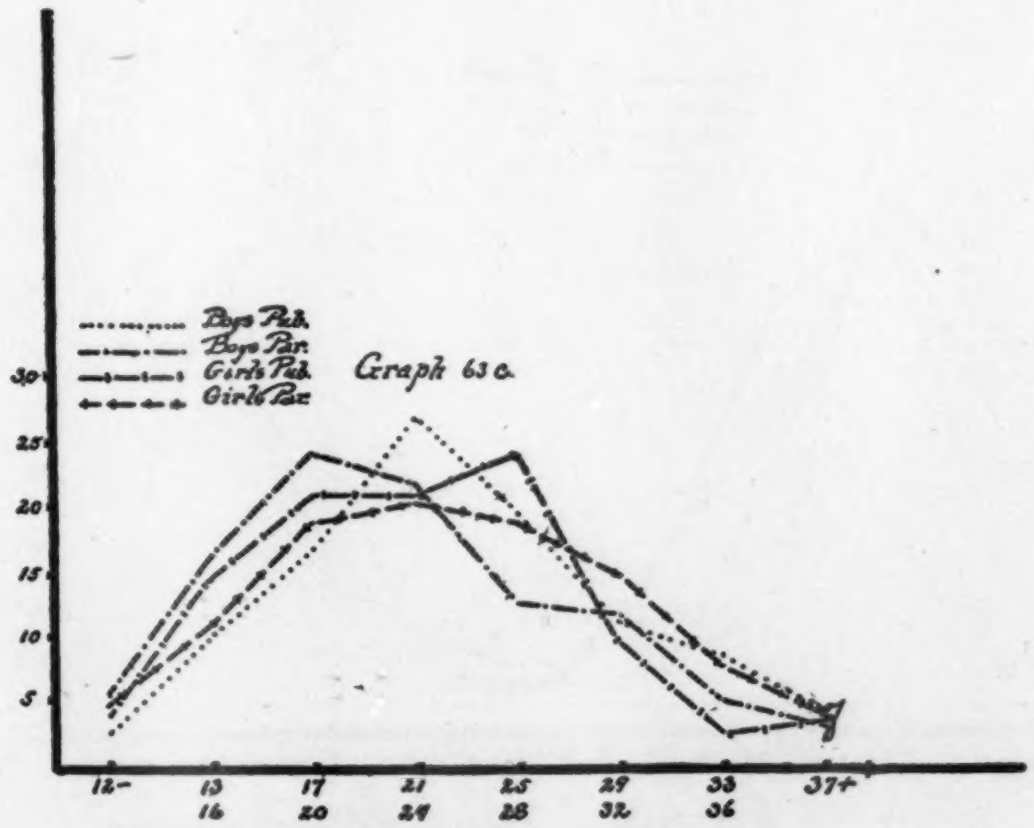
SENTENCE TEST. NUMBER OF IDEAS. 14 YEARS.



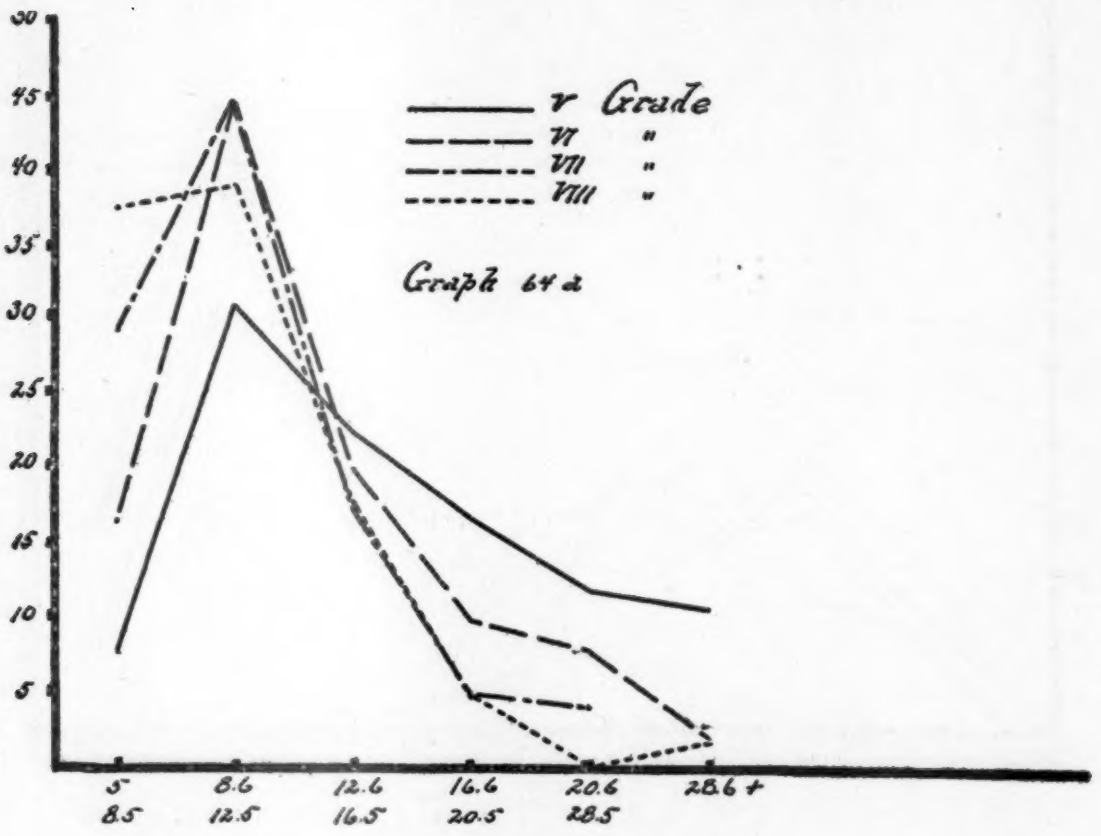
SENTENCE TEST. NUMBER OF IDEAS. 15 YEARS. BOYS.



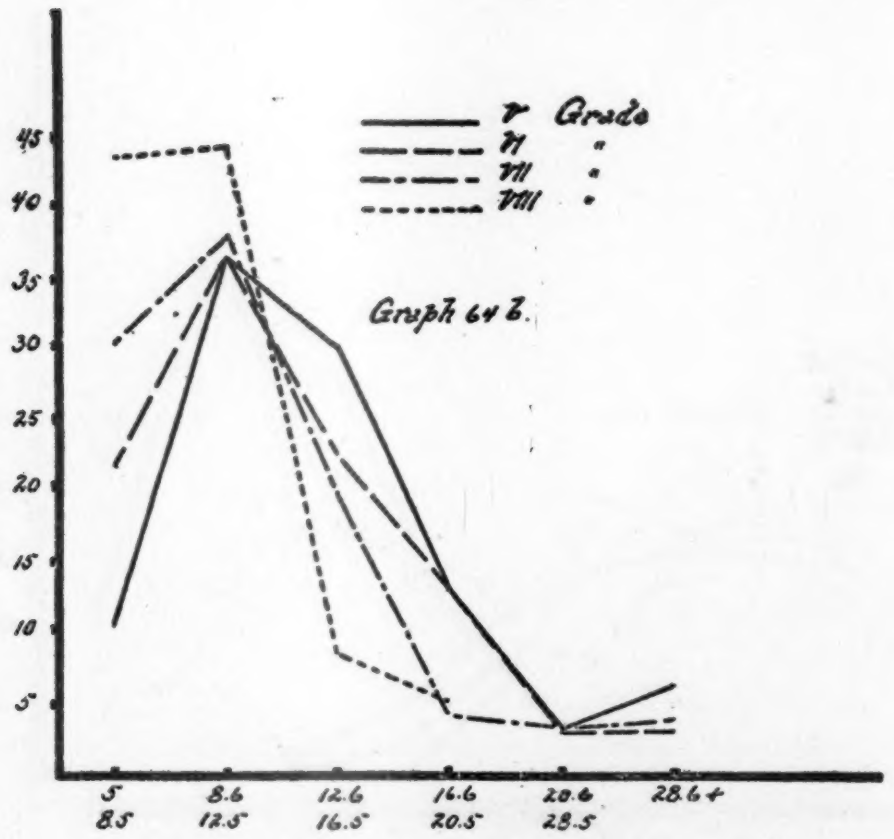
SENTENCE TEST. NUMBER OF IDEAS. 15 YEARS. GIRLS.



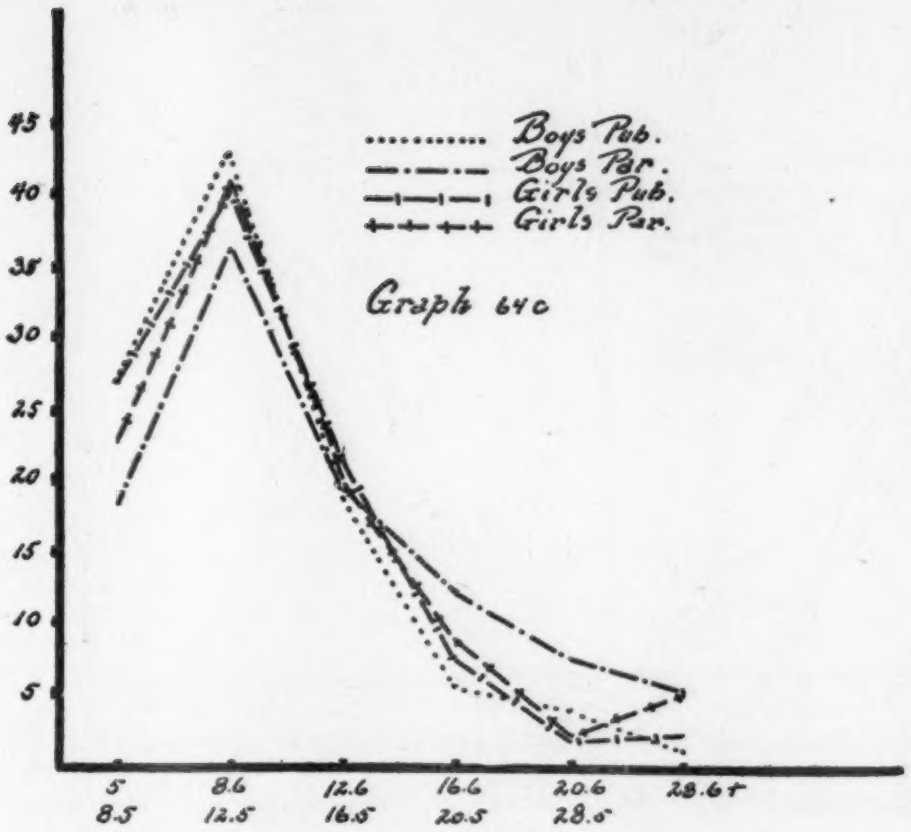
SENTENCE TEST. NUMBER OF IDEAS. 15 YEARS.



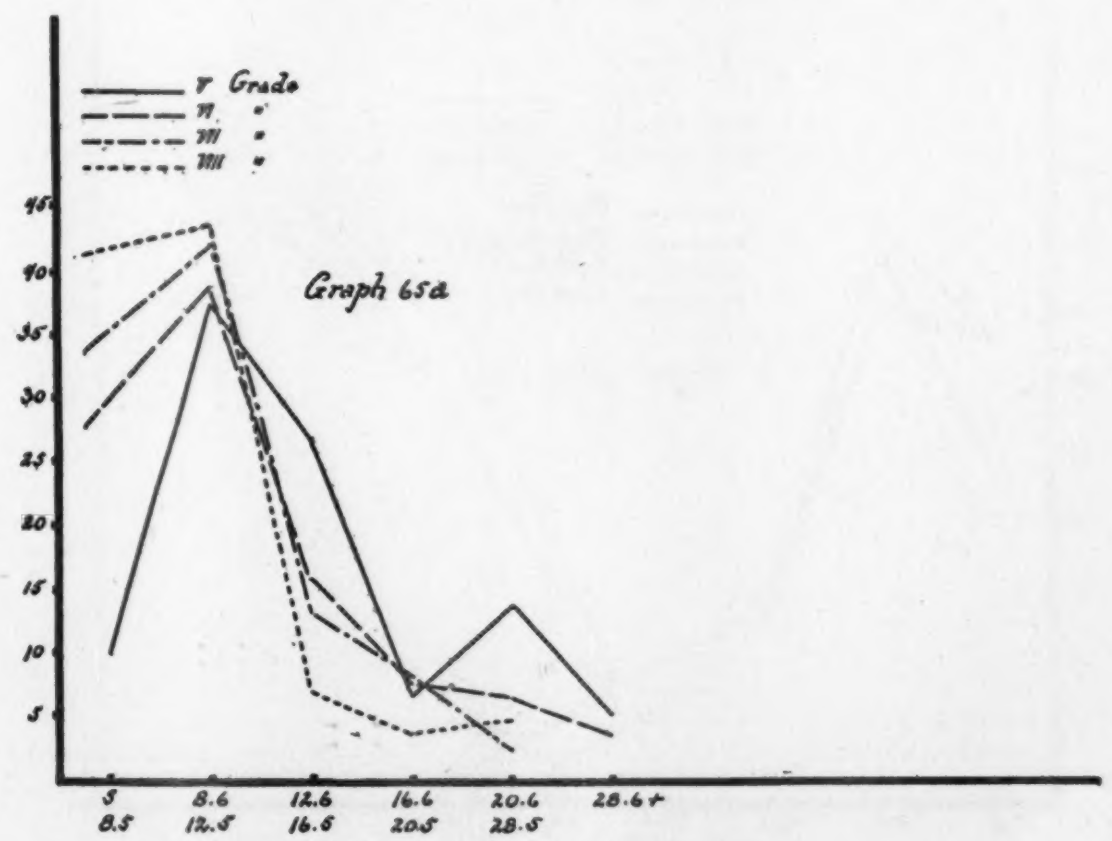
SENTENCE TEST. INDEX OF IDEAS. 14 YEARS. BOYS.



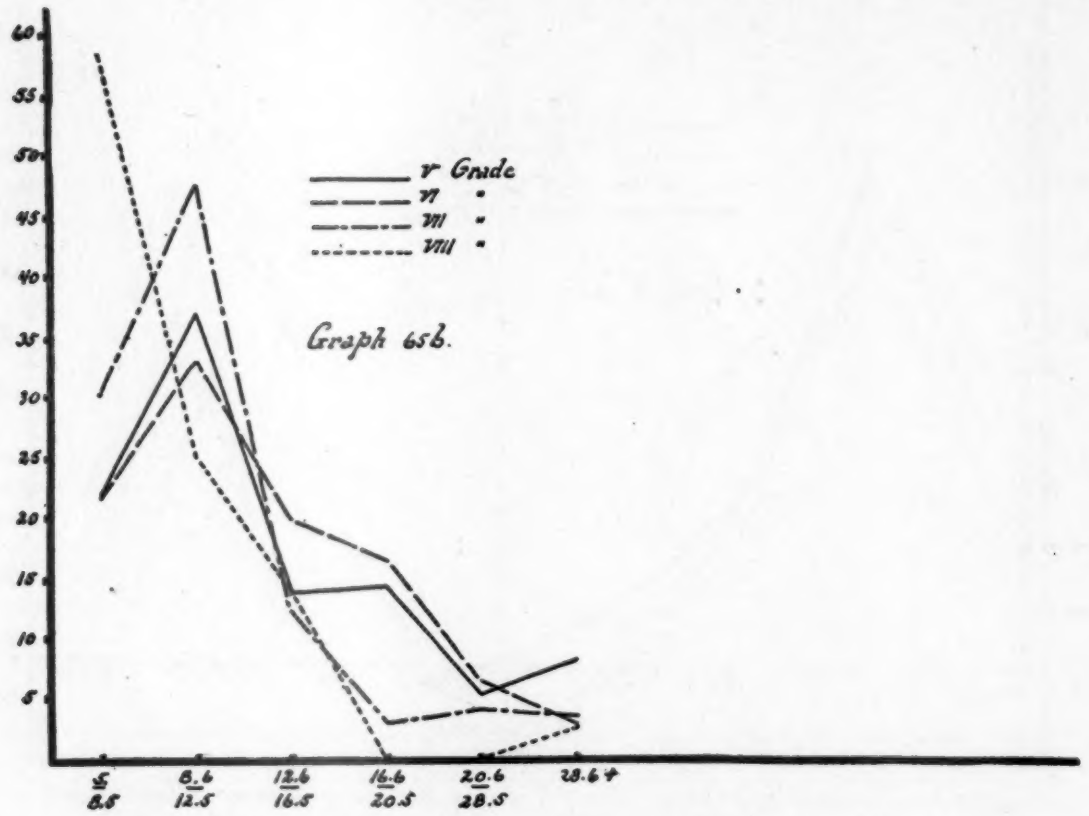
SENTENCE TEST. INDEX OF IDEAS. 14 YEARS. GIRLS.



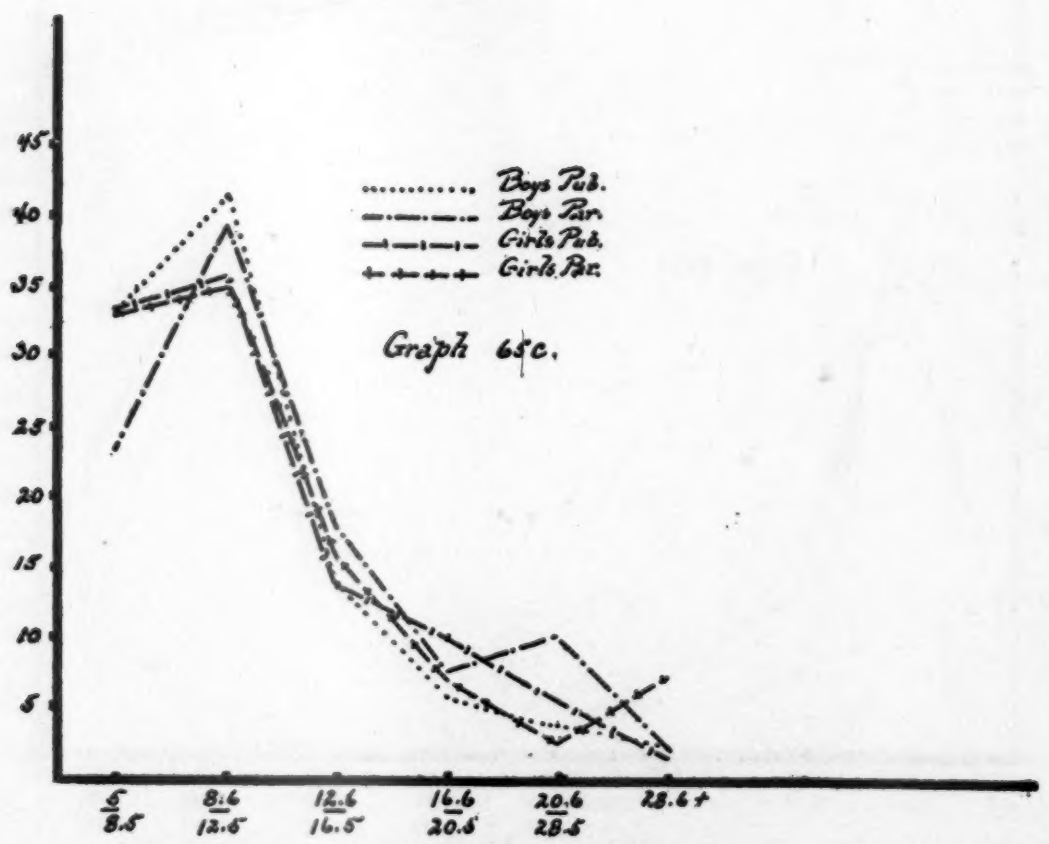
SENTENCE TEST. INDEX OF IDEAS. 14 YEARS.



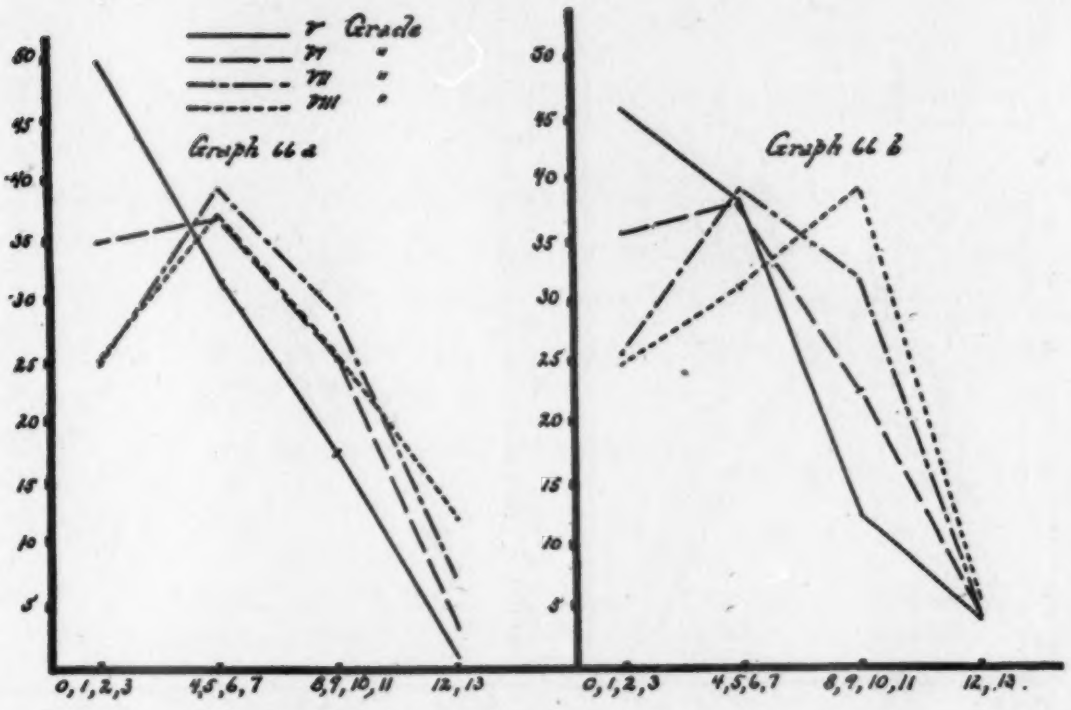
SENTENCE TEST. INDEX OF IDEAS. 15 YEARS. BOYS.



SENTENCE TEST. INDEX OF IDEAS. 15 YEARS. GIRLS.

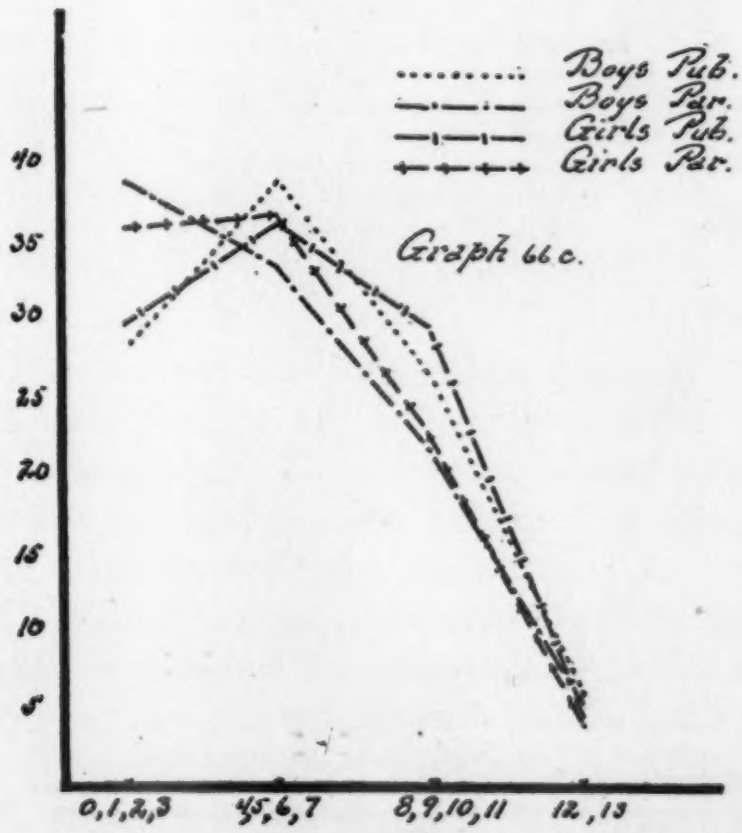


SENTENCE TEST. INDEX OF IDEAS. 15 YEARS.

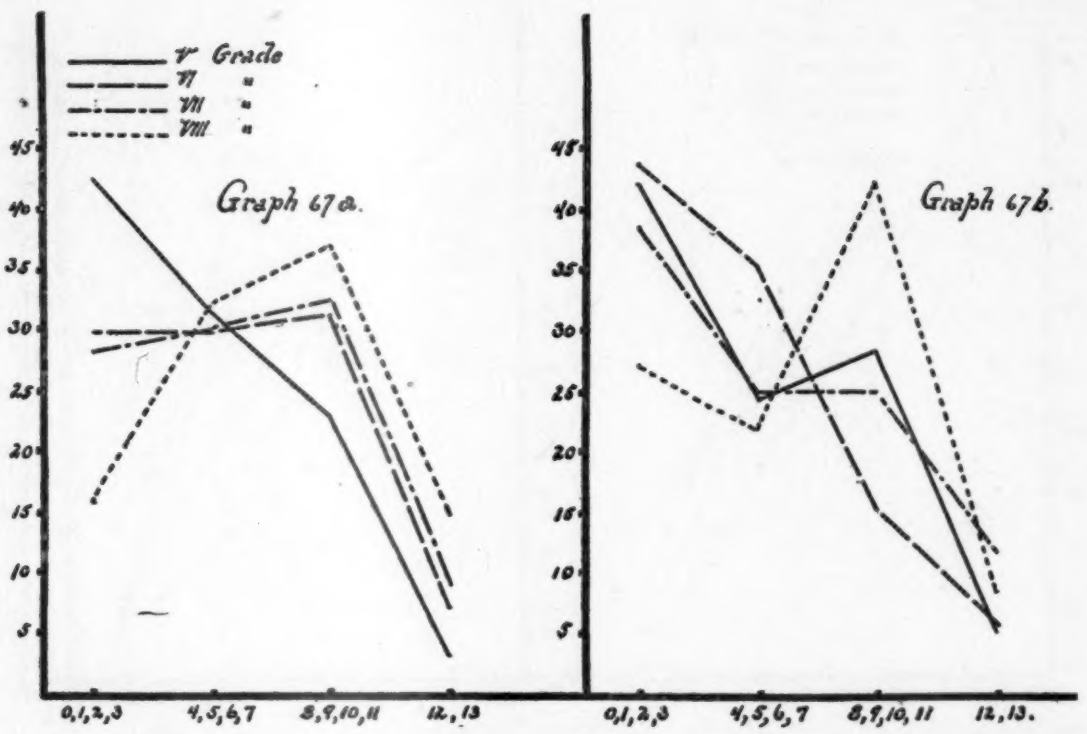


SENTENCE TEST. NUMBER OF SENTENCES WITH AN ASSOCIATION TIME OF 2 SECONDS OR LESS.

14 YEARS. BOYS. 14 YEARS. GIRLS.

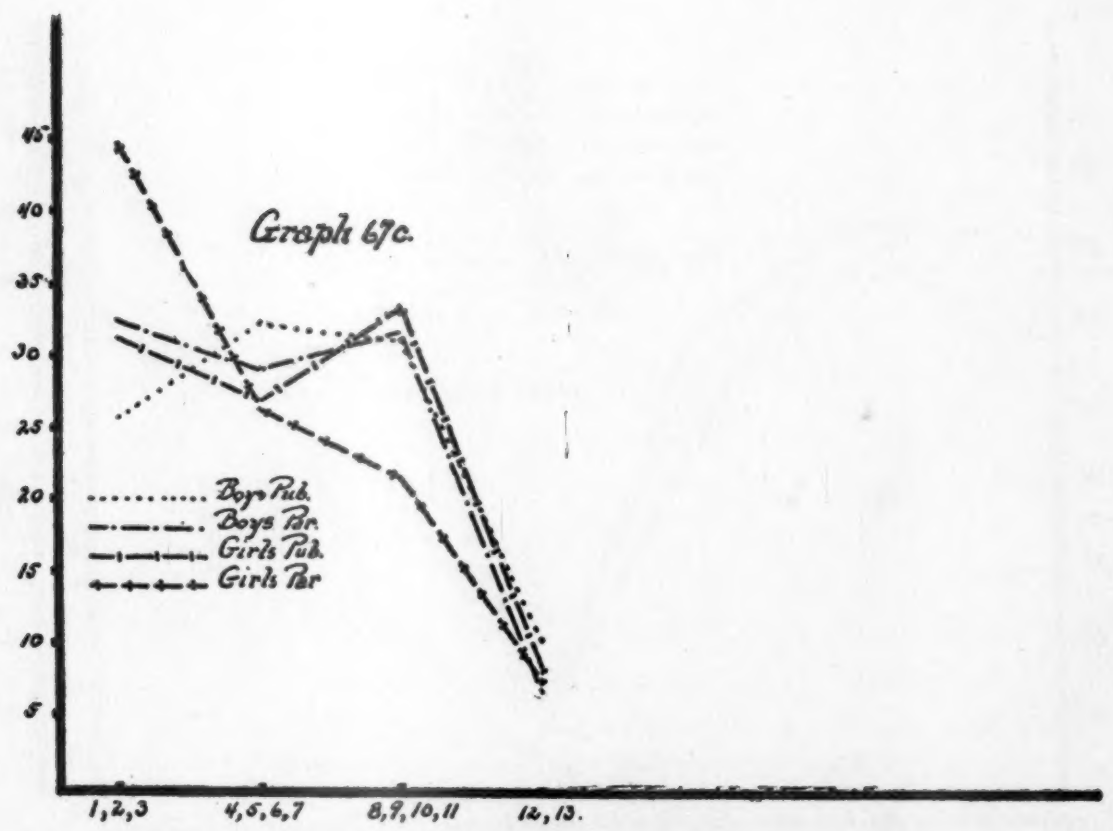


SENTENCE TEST. NUMBER OF SENTENCES WITH AN ASSOCIATION TIME OF 2 SECONDS OR LESS. 14 YEARS.



SENTENCE TEST. NUMBER OF SENTENCES WITH AN ASSOCIATION TIME OF 2 SECONDS OR LESS.

15 YEARS. BOYS. 15 YEARS. GIRLS.



SENTENCE TEST. NUMBER OF SENTENCES WITH AN ASSOCIATION TIME OF 2 SECONDS OR LESS. 15 YEARS.

Section XIV—Association by Opposites

Table 68—Association by Opposites. Accuracy. 14 years.
Table 69—Association by Opposites. Accuracy. 15 years.

Materials—A page containing twenty words, printed one under another at the left side of the page. A stop-watch. (See Whipple's Manual, Test 34c.)

Eight such pages were used, as follows:

1	2	3	4	5	6	7	8
Good	Bad	Asleep	Front	Strong	Inside	Worst	Wise
Outside	Inside	Near	Safe	Best	Tall	Never	Joy
Quick	Slow	Fast	Awake	Always	Enemy	Dry	Upper
Tall	Short	Kind	Raw	Front	Big	Foolish	New
Big	Little	Raw	Shut	Wet	Good	Weak	Busy
Loud	Soft	Noisy	Easy	Foolish	Sorry	Distant	Generous
White	Black	Early	Rude	Pretty	Sick	Slow	Vacant
Light	Dark	Nice	Winter	Dead	Poor	Kind	Tender
Happy	Sad	Sharp	Low	Honest	Similar	Horrid	Regular
False	True	Night	Day	Cross	False	Cheap	Stale
Like	Dislike	Cheap	Sharp	Bright	Prompt	Left	Absent
Rich	Poor	Wrong	Late	Safe	Black	Honest	Heavy
Sick	Well	Soft	Stupid	Smooth	Soft	Dull	Even
Glad	Sorry	Stupid	Old	Summer	Rough	Pleasant	Certain
Thin	Thick	Young	Sunny	High	Narrow	Rough	Love
Empty	Full	Patient	After	Easy	Evening	Dirty	Few
War	Peace	Cloudy	Short	Long	Stout	Quiet	Raise
Many	Few	Before	Right	Polite	Rapid	Soft	Silent
Above	Below	Open	Lazy	Lazy	Peace	Ugly	Shallow
Friend	Enemy	Clean	Alive	Right	Few	Patient	Orderly

The first five lists were easier than the last three. The first five were used in the fourteen-year series, and the last three in the fifteen-year. The first two are the standard blanks recommended by Whipple, and furnished by Stoelting. The others were made out for this series of tests.

Criticism—We are convinced that the test is one which is decidedly modified by communication. It seemed very necessary, therefore, to have several blanks, but it was impossible for us to standardize them with any accuracy. The first five are easier than the last three, and do not differ very much in difficulty. Of the last three, the one beginning "Wise" is the hardest.

Method of administering the test—The experimenter began as follows:

"Do you know what I mean when I say that one word means just the opposite of another word? For instance, what is the opposite of hot?" If the correct answer was received, the experimenter continued with "up" and "straight" as additional illustrations. None of these words appear on any of the test sheets. If the experimenter did not receive the correct answer to his original question, he tried to explain the matter further. Sometimes it was necessary to tell the child that "cold" was the opposite of "hot," and then try the other illustrations. Occasionally we had to resort to such leading questions as the following:

"If you are moving in an elevator, and are not going up, in what direction are you going?" A child who needed that kind of explanation, however, never made a success of the test. When the experimenter felt that the child understood the test as well as he was able, he continued as follows:

"On the other side of this piece of paper there is a list of words printed one under another. What I want you to do is to write on the paper after each word, the word that means just the opposite of the one you see there. For instance, if you saw "hot" there, what would you write after it? Yes. Now begin at the top and take the words in order. If you pass one, you can't go back to it, so try to get each one as you go along, and do it as fast as you can."

The stop-watch was started as the child looked at the first word, and stopped as he finished writing the last one. The experimenter sat with his eye on the stop-watch, and told the child, in case he paused more than 30 seconds on any one word, to pass on to the next word.

Method of dealing with results—For each list of words, a list of opposites which were to receive full credit, and of those to receive half credit, was made out. The entire series of lists with the credits given is printed below. Misspelled words were not counted as incorrect, but in case of change of form, i.e., adverbs used for adjectives, one half credit only was given. The list was

made up gradually as the papers were marked. Each new case was made the subject of consultation, but the final decision always rested with Mrs. Fischer, who supervised all the evaluating. The result of the test was recorded each time in terms of the time of the total test, and the accuracy of the series in per cents. In this case, a combined measure of time and accuracy was of comparatively little significance, the accuracy being the important one. Children who were uncertain and inaccurate were usually slow, and there was no reason to think they could have done much better by taking more time. The table of results, and the comparative graphs are accordingly based on the percentage of accuracy.

Words getting 1.			Words getting 2.
Wrong	—	Good	— Bad, evil, poor
In	—	Outside	— Inside, in-doors
Long, slowly	—	Quick	— Slow, sluggish
Little, tiny, small, littler	—	Tall	— Short, low
Short, narrow	—	Big	— Little, small, tiny
Softly, still, silent, easy, noisless	—	Loud	— Soft, quiet, low, faint
Dirty, dark	—	White	— Black
Dim, night	—	Light	— Dark, heavy, darkness
Mad	—	Happy	— Sad, grieved, sorry, unhappy, gloomy
Good, correct, truthful, truth, right, upright	—	False	— True, real, natural, faithful
Contrary, opposite	—	Like	— Dislike, dissimilar, unlike, different, hate
	—	Rich	— Poor
Better	—	Sick	— Well, healthy
Mad, sorrow, angry	—	Glad	— Sorry, sad, grieved, unhappy
Heavy	—	Thin	— Thick, stout, fat
Rented	—	Empty	— Full, fill, occupied
Quiet	—	War	— Peace
Little, one, none, nothing	—	Many	— Few
Down, low	—	Above	— Below
Unfriendly, stranger	—	Friend	— Enemy, foe

Words getting 1.			Words getting 2.
Right, well	—	Bad	— Good, nice, fine
Out	—	Inside	— Out of doors, outside
Quickly, rapidly, swiftly	—	Slow	— Quick, fast, rapid, swift,
Big, far, high	—	Short	— Long, tall
Tall, fat	—	Little	— Big, large, much
Coarse, rough	—	Soft	— Loud, hard, harsh
Clean, light	—	Black	— White
White	—	Dark	— Light, bright, sunny
Merry, pleasant, jolly, gay	—	Sad	— Happy, joyful, glad, cheerful
Dishonest, wrong, traitor, lie bad	—	True	— Untrue, false, deceitful, unfaithful, faithless
Liked	—	Dislike	— Like
Well, right	—	Poor	— Rich, wealthy, well-to-do, good
Poor, bad	—	Well	— Sick, ill, unwell, poorly
Cheerful, jolly, gay	—	Sorry	— Glad, happy, joyful
Fine	—	Thick	— Thin, sparce
Scant	—	Full	— Empty, vacant
Noise, disturbance, fight, riot, misery, sadness, trouble, fighting, quarrel, excitement	—	Peace	— War

None, crowd, much, more, plenty	—	Few	—	Many, lots, most, several, a number, numerous
High, up, on top	—	Below	—	Above
Friendly	—	Enemy	—	Friend, ally

Words getting 1.				Words getting 2.
Wake	—	Asleep	—	Awake
Away	—	Near	—	Far
Long, slowly	—	Fast	—	Slow, sluggish
Selfish, hard rough, rude, bad, ugly, angry, sassy	—	Kind	—	Cross, cruel, harsh, hateful, unkind, mean
Cook, boiled, done, fried, prepared	—	Raw	—	Cooked, baked, manufactured, finished
Peaceful, easy, softly	—	Noisy	—	Quiet, silent, still, noiseless
	—	Early	—	Late, tardy
Cranky, ugly, hateful, mean, untidy, unpolite, naughty, cross, rough, unkind	—	Nice	—	Bad, horrid, nasty, shabby, rude
Stupid, round, slow, stump, sweet,	—	Sharp	—	Blunt, dull, mild, stumpy
	—	Night	—	Morning, day
High, good	—	Cheap	—	Dear, expensive, costly
Good	—	Wrong	—	Right
Coarse, rough	—	Soft	—	Loud, hard, harsh
Sharp, learning, learned, quick, alert	—	Stupid	—	Bright, smart, intelligent, wise, clever, brilliant
Older	—	Young	—	Old
Grumpy, fidgity, wild, cross cranky, restless, nervous	—	Patient	—	Doctor impatient
Sunshine, light, nice	—	Cloudy	—	Bright, fair, clear, sunny, sunshiny, cloudless
Now	—	Before	—	After, behind, afterwards
	—	Open	—	Shut, close, closed
Black, cloudy	—	Clean	—	Soiled, dirty

Words getting 1.				Words getting 2.
Backwards	—	Front	—	Back, behind, rear
Caught, harmed, stolen, careless, danger	—	Safe	—	Unsafe, dangerous, lost
	—	Awake	—	Asleep, sleep, sleepy
Cook, done, fried, boiled, prepared	—	Raw	—	Cooked, baked, manufactured, finished
	—	Shut	—	Open, opened
	—	Easy	—	Difficult, hard, uneasy

Pleasant, good, gentle, fine, kind, smooth	—	Rude	— Polite, mannerly, nice
Spring, fall	—	Winter	— Summer
Up	—	Low	— High
Evening	—	Day	— Night
Stupid, round, slow, stump, sweet	—	Sharp	— Blunt, dull, mild, stumpy
Soon	—	Late	— Early, on time
Sharp, learned, learning, quick, alert	—	Stupid	— Clever, bright, brilliant, intelligent, smart, wise
Younger, newer	—	Old	— Young, new
Dreary, foggy, shade, rainy	—	Sunny	— Cloudy, dark, gloomy, shady
Now	—	After	— Before
Big, far, high	—	Short	— Long, tall
Bad	—	Right	— Left, wrong
Alive, awake, bright, busily, doing, earnest, fast, frisky, quick, spry, studious, willing, work, worker, working, ambitious	—	Lazy	— Active, busy, diligent, energetic, hard-working, industrious, lively, thrifty
Stupid, death	—	Alive	— Dead

Words getting 1.			Words getting 2.
Easy, light	—	Strong	— Feeble, weak, delicate
Bad, least, poor, wrong, worse, rotten	—	Best	— Worst, poorest
No time, sometimes, rarely, seldom	—	Always	— Never
Backwards	—	Front	— Behind, rear, back
	—	Wet	— Dry
Bright, correct, right, sane, smart, witty, sense, clever, serious	—	Foolish	— Wise, sensible
	—	Pretty	— Homely, ugly
Life	—	Dead	— Alive, live, living
Steal, cheat, liar, lie, thief, bad, guilty, stealing, untrue, untruthful, unhonest	—	Honest	— Dishonest, crooked, false, deceitful
Contented, good, happy, kind, nice, straight, smiling, peaceful, cheery, uncrossed, parallel	—	Cross	— Pleasant, joyful, merry, good-natured, agreeable
Lazy, feeble, dumb	—	Bright	— Dark, dim, dreary, dull, stupid, gloomy, sad, melancholy

Caught, stolen, danger, harmed, careless	—	Safe	— Dangerous, unsafe, lost
Harsh, crooked, hilly, humpy, uneven, rocky, bumpy, irregular, rugged	—	Smooth	— Rough, wrinkled
	—	Summer	— Winter
Little, small, short	—	High	— Low
	—	Easy	— Difficult, hard, uneasy
Little, small	—	Long	— Short
Unpolite, indecent, mean, ill-mannered, impatient, unrefined, unmanly	—	Polite	— Impolite, unmannerly, rude, impertinent, boorish
Work, studious, earnest, bright fast, quick, busily, willing, noiwake, worker, ambitious, spry, alive, working, frisky	—	Lazy	— Active, diligent, energetic, industrious, busy, hard-working, lively, thrifty
Bad	—	Right	— Wrong, left

Words getting 1.			Words getting 2.
Out	—	Inside	— Outside, out-of-doors
Little, tiny, small, littler	—	Tall	— Short, low
Friendly	—	Enemy	— Friend, ally
Short, narrow	—	Big	— Little, small, tiny
Wrong	—	Good	— Bad, evil, poor
Cheerful, jolly, gay	—	Sorry	— Glad, happy, joyful
Better	—	Sick	— Well, healthy
Well, right	—	Poor	— Rich, wealthy, well-to-do, good
Unsimilar, opposite, contrary	—	Similar	— Dissimilar, unlike, different
Upright, right, truth, good, correct, truthful	—	False	— True, real, natural, faithful
Slow, delayed, behind	—	Prompt	— Late, tardy
Clean, light	—	Black	— White
Rough, coarse	—	Soft	— Hard, harsh, loud
Soft, quiet, good, even	—	Rough	— Smooth, gentle
Big	—	Narrow	— Wide, broad
Light, day	—	Evening	— Morning, dawn
Small, light	—	Stout	— Thin, weak, slim, slender, skinny, lean
Misery, quarrel, riot, fighting, sadness, disturbance, noise, fight, trouble, excitement	—	Peace	— War
Much, more, crowd, none, plenty	—	Few	— Many, lots, most, several, a number, numerous

Words getting 1.				Words getting 2.
Highest, most, good, better, fine	—	Worst	—	Best, finest
Frequently, often, some, now , sometimes	—	Never	—	Always
Moist, saturated	—	Dry	—	Wet, soaked, damp
Bright, clever, correct, right, sane, sense serious, smart, witty	—	Foolish	—	Sensible, wise
Active, healthy, lively, muscular, steady, well	—	Weak	—	Firm, powerful, strong
Next, here, friendly, present	—	Distant	—	Close, near
Quickly, rapidly, swiftly	—	Slow	—	Fast, quick, rapid, swift
Angry, bad, hard, rough, rude, sassy, selfish, ugly	—	Kind	—	Cross, cruel, harsh, hateful, mean, unkind
Decent, fair, fine, good, kind,	—	Horrid	—	Agreeable, nice, pleasant
Good, high	—	Cheap	—	Costly, dear, expensive
Staid, here	—	Left	—	Right, taken
Bad, cheat, guilty, lie, liar, steal, stealing, thief, unhonest, untrue, untruthful	—	Honest	—	Crooked, deceitful, dishonest, false
Alive, awake, energetic, fair, intelligent, interested, piercing, quick, spry	—	Dull	—	Brilliant, bright, clear, keen, sharp, smart, shining
Sad, sorrowful, gloomy, peevish	—	Pleasant	—	Unpleasant, cross, grouchy, hateful, horrid, mean
Even, good, quiet, soft	—	Rough	—	Gentle, smooth
Clear, decent, neat, orderly, pure, tidy, white	—	Dirty	—	Clean, spotless, washed
Disturbing, lively, moving, racket, restless, stirring	—	Quiet	—	Boisterous, loud, noisy, talkative
Coarse, rough	—	Soft	—	Hard, harsh, loud
Attractive, decent, good, kind, neat, nice, polite	—	Ugly	—	Pretty, handsome, beautiful. comely
Cranky, Cross, fidgity, grumpy, nervous, restless, wild	—	Patient	—	Doctor, impatient

Words getting 1.				Words getting 2.
Dull, dumb	—	Wise	—	Foolish, stupid, unwise
Dreary, worry, joyless, unhappy, sad, sorry	—	Joy	—	Sorrow, sadness, grief
Below, down, downer, downward	—	Upper	—	Lower, under, bottom
Older	—	New	—	Old
Dull	—	Busy	—	Lazy, indolent, idle, unemployed, slack

Greedy, mean, miser, hard	— Generous	—	Miserly, stingy, selfish
Rented	— Vacant	—	Full, occupied, filled
Coarse, rough, mean	— Tender	—	Tough, hard, crude
Substitute, sub, unregular	— Regular	—	Irregular
	— Stale	—	Fresh
	— Absent	—	Here, present, there
Easy	— Heavy	—	Light
Crooked	— Even	—	Rough, uneven
	— Certain	—	Uncertain
	— Love	—	Hate, hatred
None, plenty, crowd, more, much	— Few	—	Many, lots, several, a number, numerous, most
Set, fall	— Raise	—	Decrease, lower, let down, seat, drop
Loud, noise	— Silent	—	Noisy, talkative
Full	— Shallow	—	High, deep
Mussed-up, noisy, unorderly	— Orderly	—	Disorderly, untidy

The use of seven different blanks—unstandardized—throws some doubt upon the interpretation of this test. The only intentional selection exercised was that the first five blanks only were used in the fourteen-year series, while the last three were used predominatingly in the fifteen-year tests. There was no other intentional selection of blanks. Just how the blanks were distributed through the various groups, is a matter we have not yet determined. We believe, however, that the blanks are sufficiently uniform in value so that large and consistent correlations can be considered significant.

Results

	Boys		Girls	
	14 years	15 years	14 years	15 years
25 perc.	66.1	67.5	70.3	71.2
50 perc.	78.3	77.3	79.5	80.0
75 perc.	87.3	85.6	88.9	88.9
Q	10.1	9.0	9.3	8.8
Limits—				
Lower	15.0	17.0	20.0	7.5
Upper	100.[1]	100.	100.	100.

Association by opposites. Accuracy in per cents. Percentiles and limits

[1] One complete failure = 0.

Correlation with school grade.

Graph, 68a—Association by Opposites. Accuracy. Boys, 14 years.

Graph 68b—Association by Opposites. Accuracy. Girls, 14 years.

Graph 69a—Association by Opposites. Accuracy. Boys, 15 years.

Graph 69b—Association by Opposites. Accuracy. Girls, 15 years.

There is a very marked and consistent positive correlation with school grade in this test for both sexes, and at both ages. The differences from grade to grade are so large, and so consistent that their significance cannot be questioned.

Comparisons of sex and school.

Graph 68c—Association by Opposites. 14 years.

Graph 69c—Association by Opposites. 15 years.

Sex—The percentiles show a slight superiority of the girls at both ages, but it is too small to be considered very significant in view of the unstandardized state of the blanks used. In the graphs, the public school boys are superior to the public school girls (particularly at fourteen years), while the reverse is true in the case of the parochial school children. A graph plotted for sex alone would show the two lines too close to indicate a clear difference.

School—The public school children are decidedly superior to the parochial school children at both ages. The difference is large enough to be of undoubted significance.

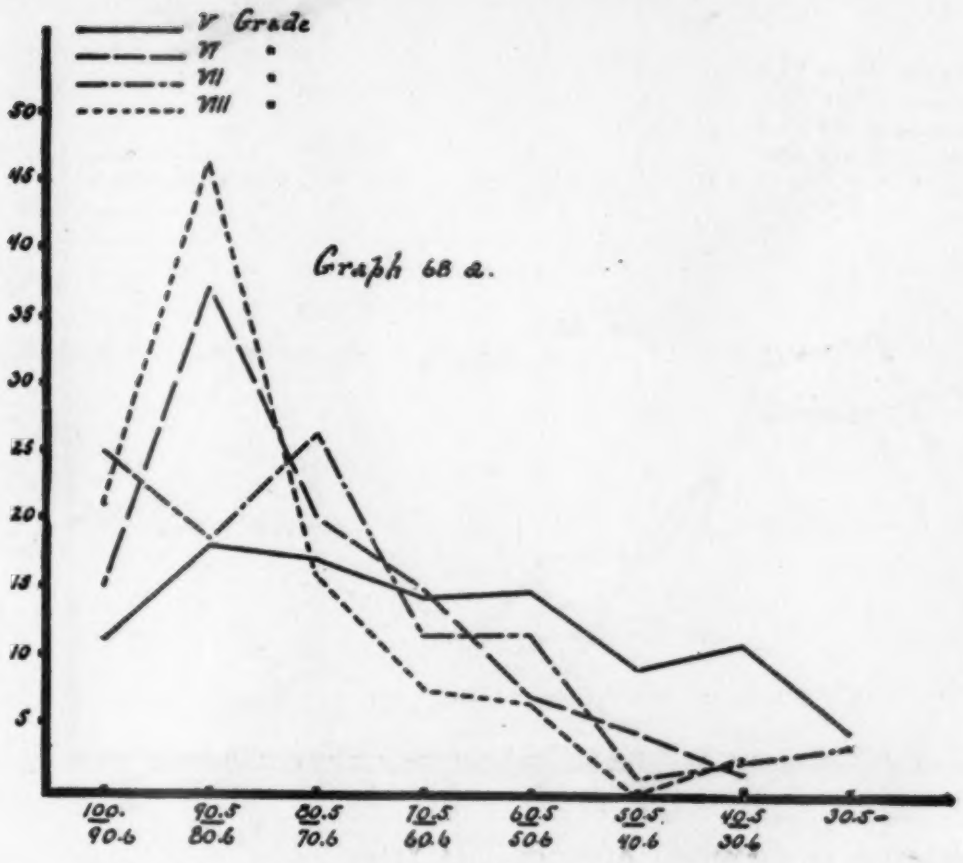
Age—The percentiles for the two ages, and the general range of the graphs is similar, though there are many more bad failures at fourteen than at fifteen. In view of the fact that the more difficult blanks were used in the fifteen-year series, it seems fair to state that the fifteen-year old children did better in the test than those of fourteen years, though no numerical comparison can be made.

TABLE 68
Association by Opposites. Accuracy. 14 years

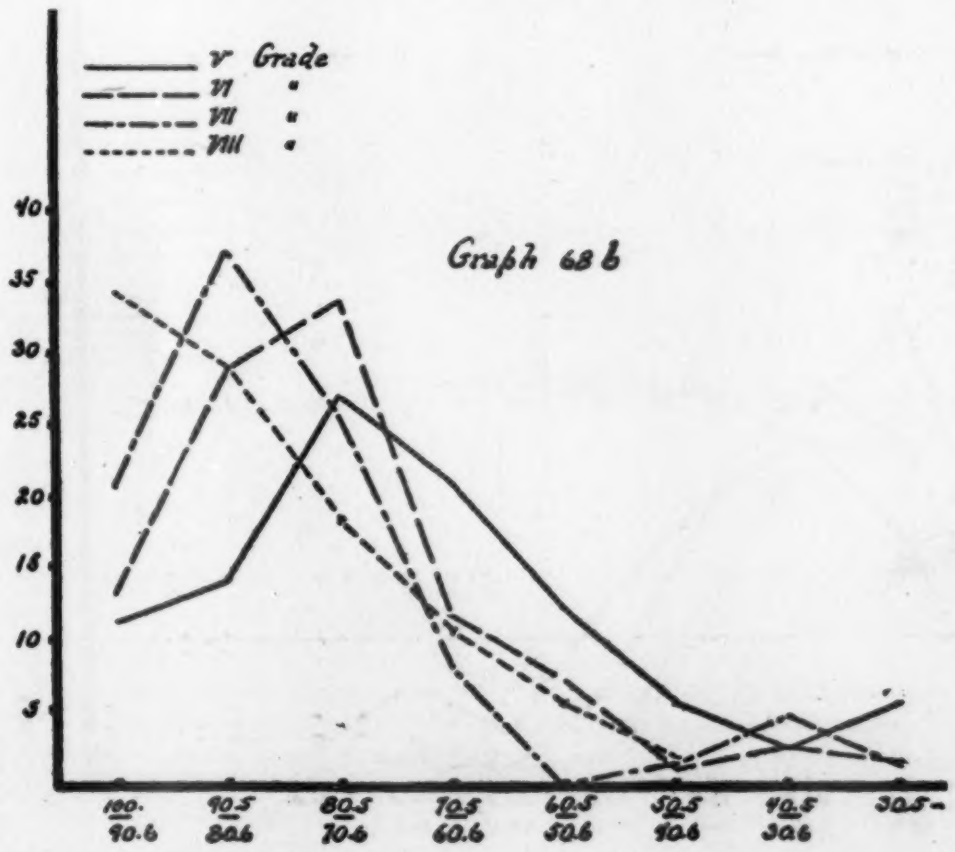
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
PUBLIC SCHOOL	100-95.6	3		2		5		1				2		0		6		3	1		
	95.5-90.6	6	17.3	6	20.5	5	38.5	5		37.5		3	17.2	6	14.3	4	32.1	5	1	45.4	
	90.5-85.6	3		12		3		4				2		10		2		5			
	85.5-80.6	8	21.1	7	48.7	2	19.2	4	1	56.2		3	17.2	2	28.6	6	25.8	1		27.3	
	80.5-75.6	5		2		3		0				4		8		4		1			
	75.5-70.6	5	19.2	4	15.4	3	23.1	0		0.0		2	20.7	8	38.1	4	25.8	1	1	13.6	
	70.5-65.6	5		3		2		0				5		5		2		3			
	65.5-60.6	2	13.5	0	7.7	1	11.5	1		6.2		4	31.0	0	11.9	1	9.7	0		13.6	
	60.5-55.6	3		1		1		0				3		1		0		0			
	55.5-50.6	2	9.6	1	5.1	1	7.7	0		0.0		1	13.8	0	2.4	0	0.0	0		0.0	
	50.5-45.6	5		0		0		0				0		0		1		0			
	45.5-40.6	2	13.5	1	2.6	0	0.0	0		0.0		0	0.0	1	2.4	0	3.2	0		0.0	
	40.5-35.6	0		0		0		0				0		1		1		0			
	35.5-30.6	1	1.9	0	0.0	0	0.0	0		0.0		0	0.0	0	2.4	0	3.2	0		0.0	
	30.5-25.6	1		0		0		0				0		0		0		0			
	25.5—	1	3.8	0	0.0	0	0.0	0		0.0		0	0.0	0	0.0	0	0.0	0		0.0	
	Total	52		39		26		15	1			29		42		31		19	3		
	Omitted	34		29		17		7	1			14		17		12		5	0		
PAROCHIAL SCHOOL	100-95.6	0		1		0		0				0		0		1		1			
	95.5-90.6	1	5.0	2	9.4	5	11.4	1		4.5		1	5.5	4	11.8	2	9.7	5		23.1	
	90.5-85.6	0		4		3		1	1			1		6		10		3	2		
	85.5-80.6	3	15.0	4	25.0	5	18.2	5	1	36.4		1	11.1	4	29.4	5	48.4	3		30.8	
	80.5-75.6	2		4		5		5				1		3		3		3			
	75.5-70.6	1	15.0	4	25.0	8	29.5	1	1	31.8		5	33.3	7	29.4	5	25.8	3		23.1	
	70.5-65.6	3		4		5		2				1		3		1		1			
	65.5-60.6	0	15.0	3	21.9	0	11.4	0		9.1		1	11.1	1	11.8	1	6.4	1		7.7	
	60.5-55.6	3		1		4		3				1		2		0		3			
	55.5-50.6	1	20.0	2	9.4	3	15.7	0		13.6		1	11.1	2	11.8	0	0.0	0		11.5	
	50.5-45.6	0		2		1		0				1		0		0		1			
	45.5-40.6	1	5.0	0	6.2	0	2.3	0		0.0		1	11.1	0	0.0	0	0.0	0		3.8	
	40.5-35.6	3		0		1		0				1		0		2		0			
	35.5-30.6	1	20.0	1	3.1	1	4.5	1		4.5		0	5.5	1	2.9	0	6.4	0		0.0	
	30.5-25.6	0		0		1		0				1		1		0		0			
	25.5—	1	5.0	0	0.0	2	6.8	0		0.0		1	11.1	0	2.9	1	3.2	0		0.0	
	Total	20		32		44		19	3			18		34		31		24	2		
	Omitted	18		27		21		18	0			8		9		24		7	1		

TABLE 69
Association by Opposites. Accuracy. 15 years

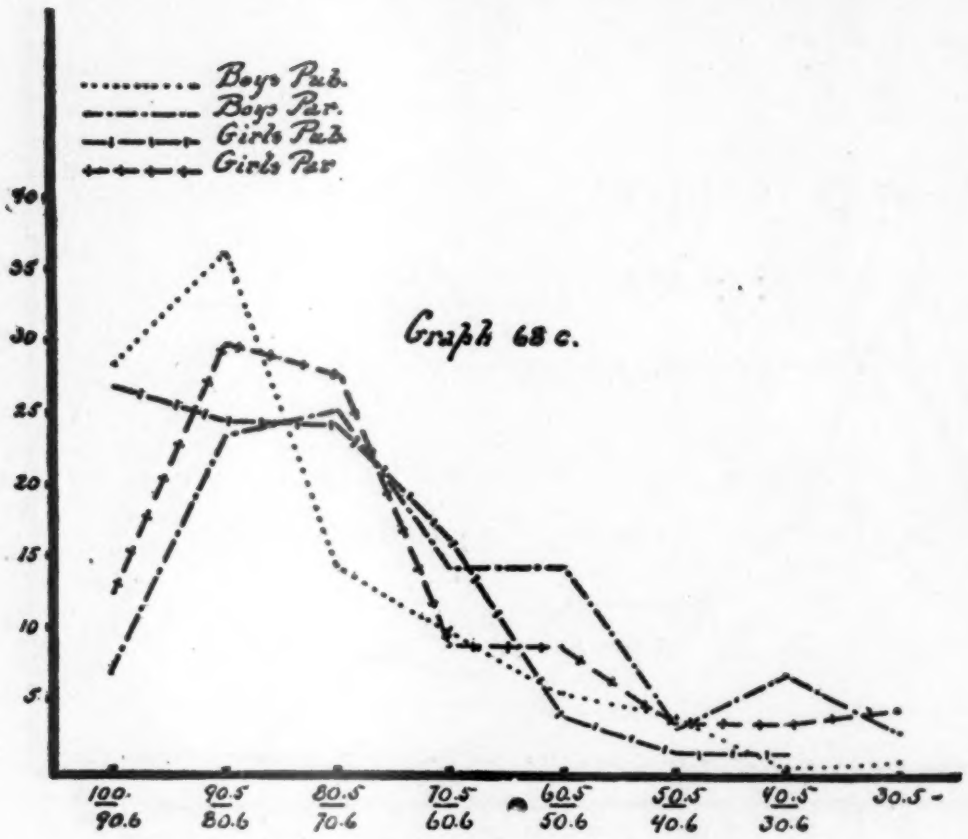
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX		VIII and IX	V		VI		VII		VIII	IX		VIII and IX
	%	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100-95.6	2		2		4		3				1		1		2		4			
	95.5-90.6	3	7.5	5	12.9	6	25.6	5	1		40.9	4	16.1	6	14.	6	26.7	7			52.4
	90.5-85.6	10		2		5		2				3		10		3		3			
	85.5-80.6	7	25.4	13	27.8	10	38.5	4			27.3	3	19.4	6	32.	3	20.0	4			33.3
	80.5-75.6	11		5		6		1	1			0		8		8		0	1		
	75.5-70.6	8	28.4	10	27.8	5	28.2	4			27.3	5	16.1	10	36.	3	36.7	0			4.8
	70.5-65.6	7		7		1		1				5		4		1		1			
	65.5-60.6	6	19.4	4	20.4	0	2.6				4.5	4	29.0	3	14.	3	13.3	1			9.5
	60.5-55.6	4		2		0						1		1		1					
	55.5-5.06	3	10.4	1	5.5	1	2.6				0.0	1	6.4		2.		3.3				
	50.5-45.6	1		1		0						1									
	45.5-40.6	0	1.5	0	1.8	0	0.0				0.0	2	9.7								
	40.5-35.6	1		1		1						0									
	35.5-30.6	3	5.9	1	3.7	0	2.6				0.0	1	3.2		0.						
	30.5—	1	1.5	0		0								1	2.						
	Total	67		54		39		20	2			31		50		30		20	1		
	Omitted	13		8		4						5		3		6					
Parochial School	100-95.6	0		0		0		4				0		1		1		3			
	95.5-90.6	0	0.0	3	6.7	2	3.9	3			23.3	1	5.	3	12.1	9	21.3	1			16.0
	90.5-85.6	2		5		12		4				2		6		12		2	1		
	85.5-80.6	2	12.5	6	24.4	5	33.3	3			23.3	3	25.	2	24.2	7	40.4	2	2		28.0
	80.5-75.6	6		9		11		3				3		3		7		9			
	75.5-70.6	2	25.0	7	35.5	4	29.4	5			26.7	2	25.	7	30.3	3	21.3	4			52.0
	70.5-65.6	4		5		6		4				1		2		2		0			
	65.5-60.6	4	25.0	5	22.2	7	25.5	2			20.0	1	10.	2	12.1	0	4.3	1			4.0
	60.5-55.6	3		1		1		0				1		0		0					
	55.5-50.6	3	18.7	3	8.9	0	2.0	1			3.3	2	15.	2	6.1	0	0.0				
	50.5-45.6	1				1		1				2		2		0					
	45.5-40.6	1	6.2		0.0	0	2.0				3.3	0	10.	1	9.1	2	4.3				
	40.5-35.6	2				1						0		0		1					
	35.5-30.6	1	9.4		0.0	1	3.9					2	10.	0	0.0	0	2.1				
	30.5—	1	3.1	1	2.2	0						0		2	6.1	3	6.4				
	Total	32		45		51		30				20		33		47		22	3		
	Omitted	3		8		11		3				4		4		4		4			



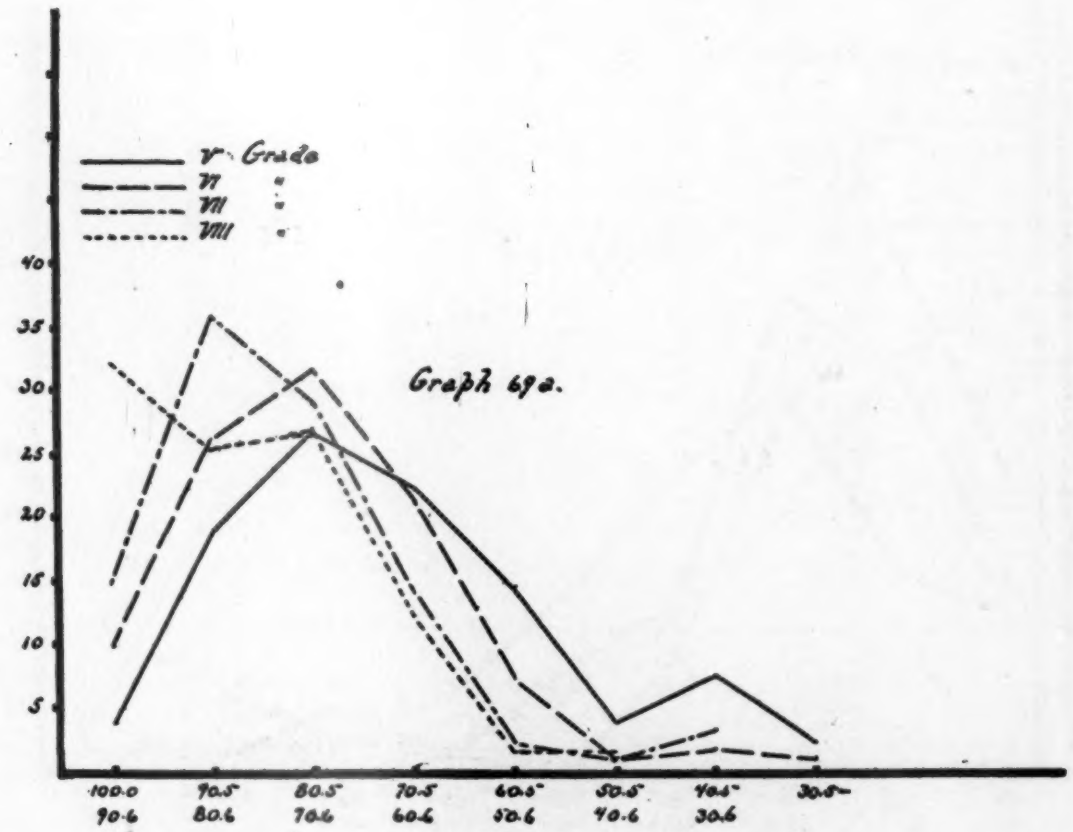
ASSOCIATION BY OPPOSITES. ACCURACY. 14 YEARS. BOYS.



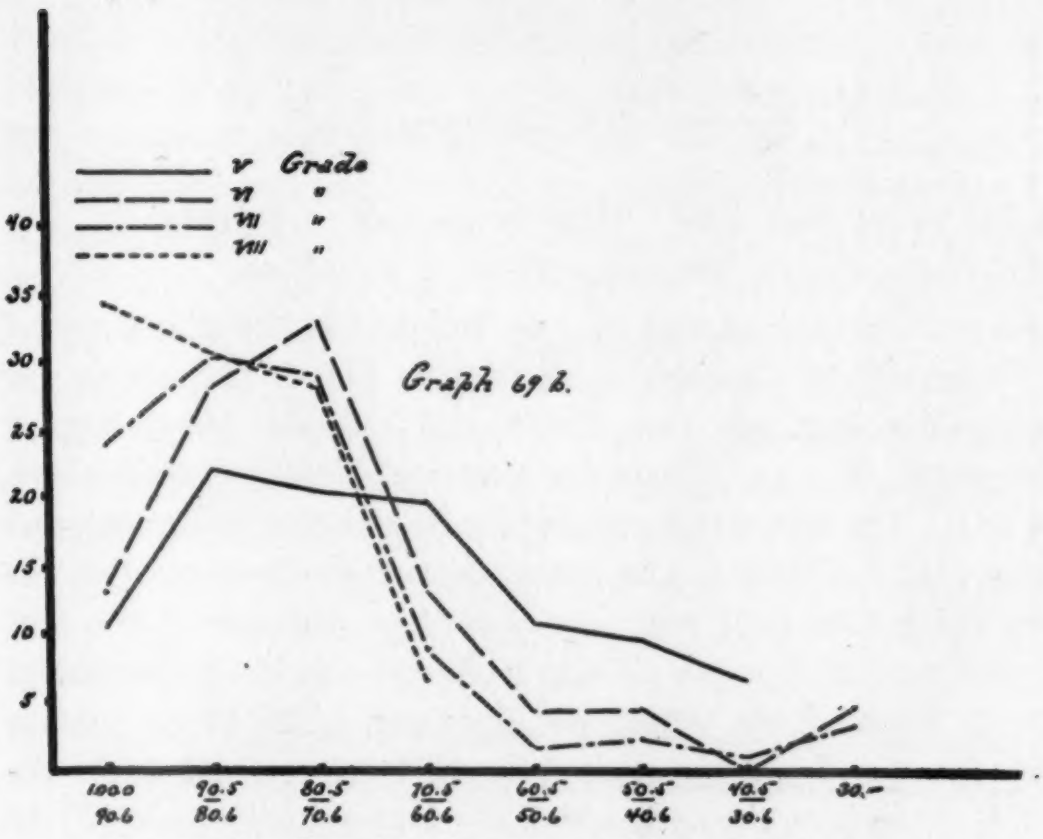
ASSOCIATION BY OPPOSITES. ACCURACY. 14 YEARS. GIRLS.



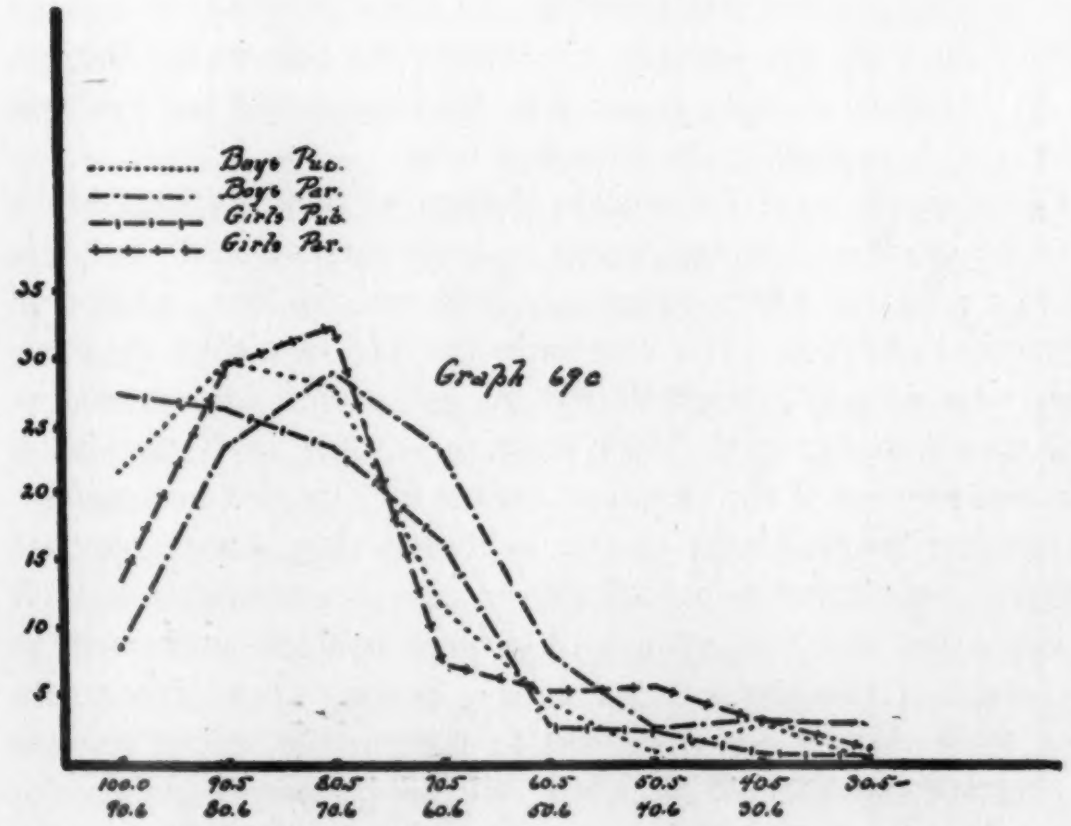
ASSOCIATION BY OPPOSITES. ACCURACY. 14 YEARS.



ASSOCIATION BY OPPOSITES. ACCURACY. 15 YEARS. BOYS.



ASSOCIATED BY OPPOSITES. ACCURACY. 15 YEARS. GIRLS.



ASSOCIATION BY OPPOSITES. ACCURACY. 15 YEARS.

Section XV—Puzzle Box

Table 70—Puzzle Box. Time in seconds. 15 years.

Materials—Puzzle box, stop-watch, button-hook.

The puzzle box used was the one designed in the laboratory of the University of Chicago by Professor Hayes for use in the Psychopathic Institute (see Healy and Fernald, Psychological Monographs, No. 54. Tests for Practical Mental Classification, page 18). The box was furnished by Stoelting and Company of Chicago, but it differs in one important respect from most of the boxes which they have sent out. Our box was one of the first lot manufactured for sale; it was painted black inside instead of white as most of the subsequent ones are. The black interior makes the test decidedly more difficult, because the hole in the bottom of the box, through which the button-hook must (?) be passed to get the first step undone, is scarcely visible as one looks through the glass into a black interior, whereas it stands out very plainly when the interior is white. In some of our tests a large part of the time was spent in discovering the hole in the bottom. In many others the hole never was discovered, and the box was opened by a method to be discussed later.

Criticism—Except for certain defects of construction, which must be specified, the test seems to us a very valuable one. It offers a situation which requires a little real thinking, applied to a practical problem. The defects in the box furnished us, however, were serious enough so that the test cannot be regarded as well standardized. The black interior, so long as it remains a constant element in the situation, cannot be regarded as a defect. In our box the post with an arm holding a ring, whose removal properly constituted step 4 of the six moves was placed at such an angle that step 4, by using a little force, could be performed at any stage of the proceedings, and in our tests was frequently done first. When we attempted to tighten the string enough so that the move could be made only in its proper order, the post gradually shifted its angle under the pressure, and the step

could be even more easily performed out of order. Perhaps the most serious defect,—and the one most difficult to correct,—was due to the gradual stretching of the strings which connect the various rings and posts. When the strings had stretched with use, it sometimes became possible by using a little force to accomplish step 3 without either step 1 or 2. In that case the box could be opened without the first two steps, and the test had to be regarded as defective. Another point at which the stretching of the strings became an important element was in the difficulty of step 1. We have already commented on the difficulty of perceiving the hole in the bottom through which the removal of the ring from the post in step 1 was supposed to be accomplished. Since the hole admitting the string connecting steps 4 and 5 was made unnecessarily large, and was placed nearly opposite step 1, it was possible to perform step 1 by putting the button-hook through this hole, and pushing with it against the ring. This method required more manual dexterity than the test was intended to involve. Moreover the difficulty of the step, when done in this way was very seriously modified by the tension of the string connecting steps 1 and 2. Since most of our children succeeded eventually in performing step 1 by this method, and the time required for it depended so much on the tension of the string we feel than an unaccountable variant of some importance enters into the results. In order to arrive at satisfactory norms for this test, it would be necessary to make a new series of trials, with these errors corrected—in so far as they can be!

Method of administering the test—The box was placed on the table before the child, and the experimenter instructed him as follows:

"Do you see how the cover of this box is fastened down?" (Calls his attention to the fastening on the front of the box.) "What I want you to do is to get the box open. You can use this button-hook (handing him the hook) any way you need to help get it open. The first thing to do is to pick the box up and study it very carefully. Look on every side of it, and turn it all about to see just how it is put together, and then try

to get it open. You don't need to break anything, or undo any strings to get it open. Don't use much force. You might bend or break something if you do, and it isn't necessary. When you find the right things to do it comes open easily. Now begin, and see how quickly you can do it—and be sure to study it first."

The experimenter started the watch when the child began to study the box. He then recorded every move the child made, in terms of the numbers of the steps. Aside from the six steps, pulling the rings or strings in the center of the box was about the only thing that could be tried which could be considered a distinct step in the attempt to open the box. The steps successfully performed were marked in the record, and the time of each successful move set down. In case the box was not opened in twelve minutes, the test was discontinued, and recorded as a failure—unless the child was very near a solution, when he was allowed to run over for a bit the time limit.

Method of dealing with results—So far no statistical use has been made of the detailed analysis of this test. The total time required, has been tabulated.

RESULTS

	Boys	Girls
25 perc.	200	342
50 perc.	304	602
75 perc.	556	Failed
Q	178	
Limits—		
Lower	45	95
Upper	720+	720+

Puzzle Box. Time in seconds. 15 years. Percentiles and limits.

Correlation with School Grade.

Graph 70a—Puzzle Box. Time. Boys, 15 years.

Graph 70b—Puzzle Box. Time. Girls, 15 years.

There is a positive correlation with school grade for both sexes. It is more marked in the case of the girls than in that of the boys.

Comparison of Sex and School.

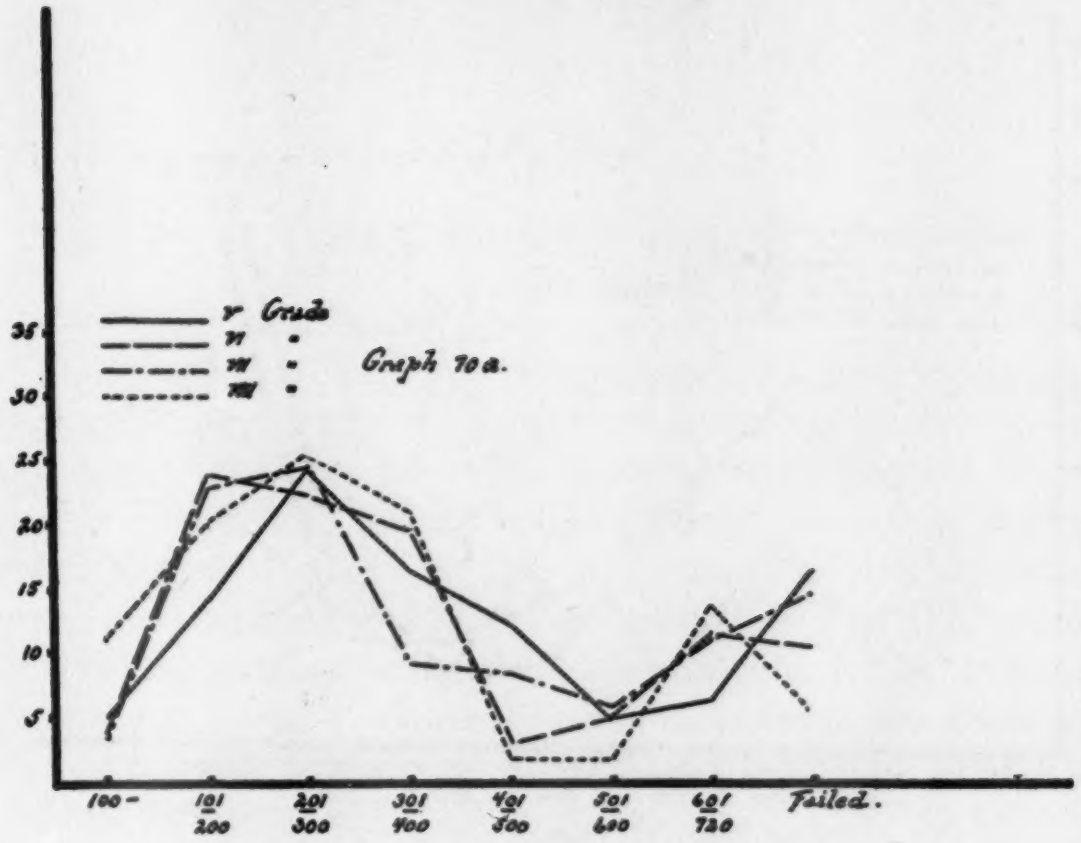
Graph 70c.

Sex—Both the percentiles and the graphs show the boys enormously superior to the girls in this test. It is the largest sex difference found in any test.

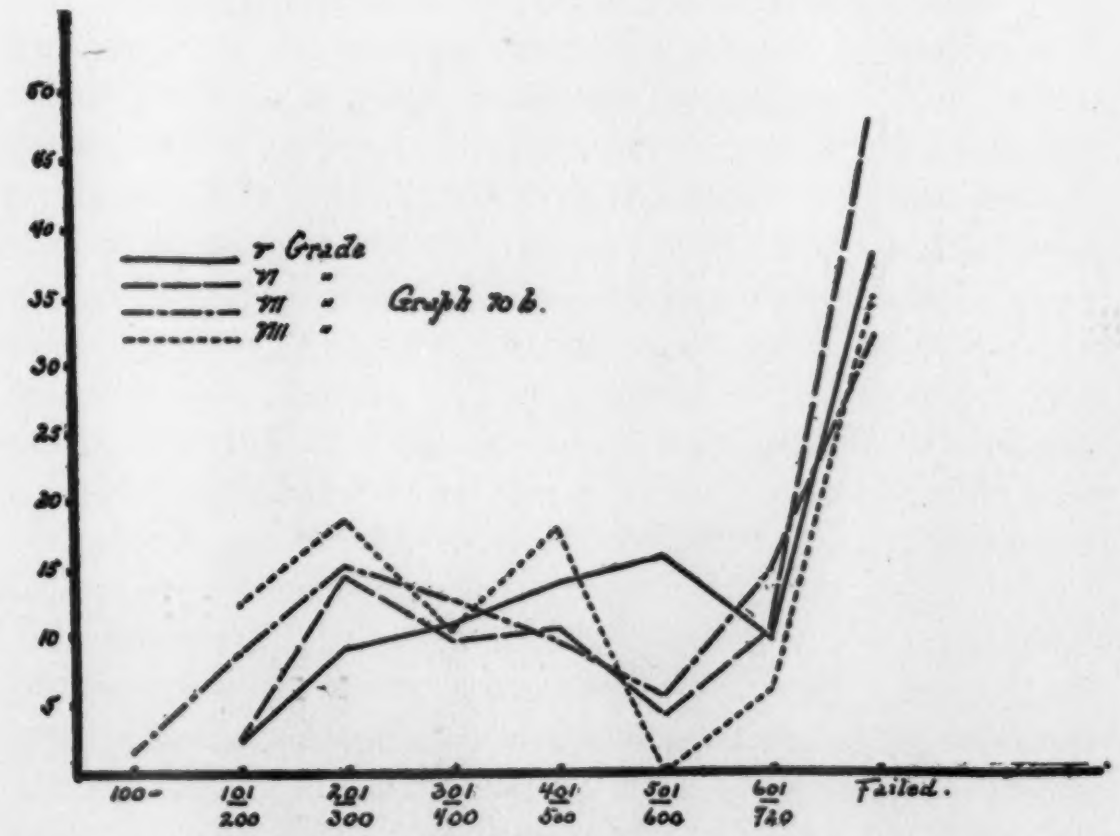
School—Though the difference of school is not so large as that of sex, it is marked. The public school children, both boys and girls, are superior to the parochial school group.

TABLE 70
Puzzle Box. 15 years

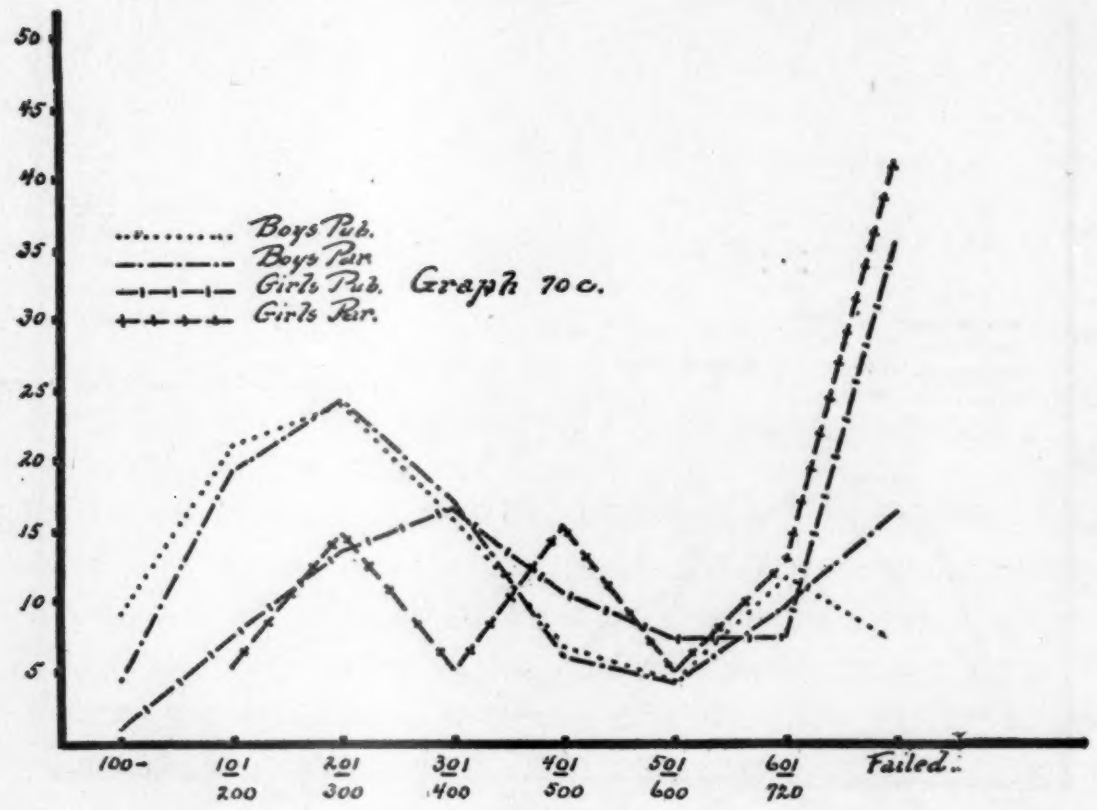
School	Grade	Boys										Girls									
		V		VI		VII		VIII	IX	VIII and IX		V		VI		VII		VIII	IX	VIII and IX	
	Seconds	No.	%	No.	%	No.	%	No.	No.	%		No.	%	No.	%	No.	%	No.	No.	%	
Public School	100-	3	4.2	4	7.4	1	2.6	3	1	22.2		0	0.0	0		1	2.9	0			
	101-200	10	13.9	16	29.6	7	18.4	4		22.2		0	0.0	2	4.5	3	8.8	3		15.8	
	201-300	20	27.8	12	22.2	9	23.7	3	1	22.2		3	9.4	5	11.4	6	17.6	3		15.8	
	301-400	13	18.1	10	18.5	4	10.5	3		16.7		7	21.9	6	13.6	5	14.7	3		15.8	
	401-500	7	9.7	2	3.7	5	13.2	0		0.0		2	6.2	4	9.1	0	0.0	5		26.3	
	501-600	3	4.2	3	5.5	3	7.9	0		0.0		6	18.7	1	2.3	3	8.8	0	1		
	601-720	7	9.7	4	7.4	5	13.2	3		16.7		2	6.2	4	9.1	5	14.7	0		5.3	
	Failed	9	12.5	3	5.5	4	10.5	0		0.0		12	37.5	22	50.0	11	32.3	4		21.6	
	Total	72		54		38		16	2			32		44		34		18	1		
	Omitted	8		8		5		6				4		9		2		2			
Parochial School	100-	2	5.9	0		2	3.8	0				0	0.0	0	0.0	0	0.0	0			
	101-200	5	14.7	8	18.2	14	26.9	5		17.8		1	4.3	0	0.0	4	8.5	2		8.	
	201-300	7	20.6	10	22.7	13	25.0	8		28.6		2	8.7	6	17.6	6	12.8	4	1	20.	
	301-400	5	14.7	9	20.5	4	7.7	7		25.0		0	0.0	2	5.9	5	10.6	0	1	4.	
	401-500	5	14.7	1	2.3	2	3.8	1		3.6		5	21.7	4	11.8	9	19.1	1	1	8.	
	501-600	2	5.9	2	4.5	2	3.8	1		3.6		3	13.0	2	5.9	1	2.1	0		0.	
	601-720	1	2.9	7	15.9	5	9.6	3		10.7		3	13.0	4	11.8	7	14.9	3		12.	
	Failed	7	20.6	7	15.9	10	19.2	3		10.7		9	39.1	16	47.0	15	31.9	12		48.	
	Total	34		44		52		28				23		34		47		22			
	Omitted	1		9		10		5				1		3		4		4			



PUZZLE BOX. 15 YEARS. BOYS.



PUZZLE BOX. 15 YEARS. GIRLS.



PUZZLE BOX. 15 YEARS.

CHAPTER IV

Summary of Results and Discussion.—Physical Tests

Correlation with School Grade.

For the physical tests as a whole, there is a positive correlation with school grade. In the case of the boys it exists in every test except steadiness, but is less marked among the girls, where it fails to appear in the test for strength of hand or in that of rapidity when continued as long as a minute. There are, however, no consistent negative correlations with school grade. In fact the only measure which suggests one is the index of fatigue for the girls. In that case it is doubtless accounted for by the fact that the upper grade girls put more real effort into the test than those in the lower grades.

In some measures, the grade correlation may be partly accounted for by an age correlation (see Chapter II, graphs 1c and 1b). Although over three-fourths of the children are under fourteen years and six months, there is a positive correlation with school grade in a graph made out by months. The various groups do not differ one from another in median age more than a month. It is possible that even this small difference is sufficient to account for correlations with height and weight, though it scarcely seems probable. It is still less probable that it could be called upon to explain correlations in strength, rapidity, or muscular coördination. In fact, many of the correlations—notably those of vital capacity and of card-sorting—are entirely too great in amount to be thus explained. Furthermore, there are several cases where the age correlation is not accompanied by any correlation in the test.

It is interesting to note that the simplest and most fundamental physical powers—strength, steadiness and rapidity—show only small and inconsistent correlations with school grade, which are entirely lacking in some of the groups. (For instance, the boys show no correlation with steadiness, and the girls none with

strength.) The tests which involve the factor of the voluntary coördination of several groups of muscles—the vital capacity and the card-sorting—show a very marked and consistent correlation with school grades. It is greatest of all in the card-sorting test, in which this factor of voluntary coördination of groups of muscles is most prominent.

The fact that boys show a larger measure of positive correlation with school grade than girls, may be due in part to the greater number of boys measured. A larger group may be expected to show more consistent correlations. It is more probable, however, that the stress laid upon physical exercise and physical development for boys, from early years on, has served to differentiate their capacity in this realm better than in the case of girls.

Sex—Except for height at fifteen years, in which the two sexes are about the same, the girls excel the boys in height, weight, steadiness, and card-sorting, while the boys excel in strength, rapidity of motion and vital capacity. It is interesting to note that though the boys are shorter and lighter in weight, they are muscularly better developed than the girls, as is shown by their superior strength and rapidity. The test of vital capacity is one which depends in part on lung development, and in part on skill in bodily coördination. (See Chap. III, Section 5.) The boys probably derive their superiority in this case from a genuinely greater lung capacity, not from superior coördination.

The results on the whole indicate that at this age the boys excel in performances where strength is the chief factor, and the girls in those where coördination and fine control of muscles is most prominent.

School—There is a more or less marked superiority of the public school children in every test except that of the index of fatigue, where no difference appears. Since the public school group is a little older—(see graph 1c) the difference in height and weight may be thus in part accounted for. The public school children are only slightly superior in rapidity, steadiness and grip—the tests where the grade correlations are also small. They

are decidedly superior in vital capacity, and in card-sorting, the tests in which the grade correlations are large.

Age—There is improvement with age in all the physical tests and measurements for both sexes. The boys make larger gains than the girls in height, weight, vital capacity, strength, and rapidity of movement while the girls gain more than the boys in steadiness, and a trifle more in card-sorting.

2. Mental Tests

Correlations with school grade.

There is a positive correlation with school grade in every phase of every one of the mental tests. The chief point of interest with regard to the grade correlations as a whole, is to note which tests are correlated in greater, and which in smaller degree. The general order for all the tests is as follows. Memory has the largest positive correlation with school grade. Next in degree comes Association by Opposites; then the sentence test as a whole; then substitution; then cancellation, and last of all, the puzzle box.

Whether or not the fact that memory shows the highest correlation with school grade, is to be construed as a criticism of the methods of instruction in the schools, is a question. It is not easy to say whether the fact is to be interpreted as an indication that current methods of teaching depend so exclusively on memory that the possession of a good memory is the chief factor in success, or whether it merely means that the possession of a good memory is one of the most constant and necessary elements of success, no matter what the method of teaching. It is unexpected too that the immediate memory of this test should show a higher degree of correlation with school grade than the test of learning, or memorizing,—the substitution test.

That the test of association by opposites should show a high degree of correlation with school grade, was to be expected from the results of its use elsewhere. Since the sentence test is distinctly related to school drill, one would also expect to find a high degree of correlation in that case, but it is interesting to note both that other tests, less obviously related, exceed it in the

amount of correlation, and that the two factors of the index of ideas, and of association time, show a higher degree of correlation with school grade, than those of the correctness of the sentences, or of the number of ideas expressed.

The two tests lowest on the list in order of grade correlation—the cancellation test, and the puzzle box—are the two which one would judge to be farthest apart with regard to the amount of mental ability required. The cancellation is such a simple, mechanical performance that one would expect a smaller grade correlation from it than from most of the other tests. But that the puzzle box, which seems to require a more original mental procedure than any other test, should stand lowest of all in grade correlation, might seem to furnish some basis for the criticism that the régime of our public schools fails to stimulate or even to recognize the less stereotyped forms of ability.

The part played by speed in the grade correlation of the substitution and sentence tests is an interesting matter. In these tests the superiority of the upper-grade children consisted not merely, or even chiefly, in the superior quality of their performance, but even more strikingly in their superior speed. The difference can be expressed in terms of efficiency. They not only do a set task of learning better, but they do it in a shorter time, and with fewer errors in the process. They not only express a greater number of ideas, but they do so in a relatively shorter period, and with less time spent in reflecting about them.

Sex—The only very large sex difference in the entire series of mental tests is that of the great superiority of the boys in the opening of the puzzle-box. There is some question as to whether the test is a fair one to apply to the two sexes, since it consists in a mechanical problem. To be sure the problem is of a simple nature, and involves no use of tools, but the fact that boys, from an early age, are more encouraged to take an active interest in mechanical construction, and accordingly understand more about how things are made, and what the simple mechanical devices are, may give them an undue advantage on the ground of training. Indeed it seems to some of the office force as though the test were as unfairly selected on the ground of sex, as a test

based on fitting together a difficult pattern for a garment would be.

Of the other tests, the girls are superior in cancellation and substitution. In both cases their superiority at fourteen years consisted in their greater speed, while in terms of accuracy alone, the boys had a very small advantage. At fifteen years the girls are superior in the two tests in both speed and accuracy.

In the other tests—memory, sentences and opposites, the sex differences are very small. The girls are slightly superior in memory, but this fact is due to the evident superiority of the parochial school girls; in the public school group, the boys are on the whole slightly superior. In the sentence test the boys are a bit superior in the correctness of the sentences and in association time, and the girls in the number and index of ideas expressed. These differences, however, are all too small to be very significant. In the opposites, there is a slight superiority of the girls, but in view of the unstandardized blanks used the difference is not large enough to be taken seriously.

School—The only test in which there is any advantage on the side of the parochial school children is memory. In that case, the result is due to the decided superiority of the parochial school girls. The parochial school boys are on the whole a bit poorer than the public school children. In the cancellation test, there is no difference of school. In all the other tests, the public school children are more or less superior. In the substitution test, the public school children fill in the three practice pages a bit faster and more accurately than the parochial school group. In the final test of the fourth page, there is no difference of school at fourteen, but the public school children are superior at fifteen. They show greater efficiency in learning, then, at both ages, but the difference is greater at fifteen than at fourteen. In the sentence tests, the public school children have the advantage. It shows in all four of its measures at fifteen, and in all except the number of ideas expressed at fourteen. It is most marked in the index of ideas, and the association time—the measures in which the grade correlations are also greatest. The opposites, more than any other test, shows a difference in favor of the public

school group. The advantage of the public school children is also decided in the puzzle-box test.

The matter can be summed up as follows: The public school children are clearly superior to the parochial school group. The differences are a little greater at fifteen than at fourteen years. Their superiority is most decided in the opposites and the puzzle-box tests, the two which are perhaps farthest removed from a relationship with school drill.

There is a larger sex difference between the two parochial school groups than between the two public school groups. In the case of the parochial school, the girls are on the whole very superior to the boys. The differences are smaller in the case of the public school children, and there are more instances in which the boys are superior to the girls.

In considering the differences between public school and parochial school children, it is worth while to point out the fact that statistics indicate that the parochial school group of working children is more fairly representative of the school as a whole than is the public school group of working children. The parochial school sends about twice as large proportion of its enrollment into industry at fourteen, as the public school. The public school group is more retarded than the parochial. While the method of constructing graphs gives an equal emphasis to each of the four school grades, it cannot, of course, take any account of the question as to whether the children from a given grade include more individuals who are below standard in one case than in the other. The statistics referred to, however, indicate that the public school working group is made up more largely of individuals who are below the standard of the group from which they come, than is the case in the parochial school. If this interpretation is fair—and we can see no reason for questioning it—it means that the superiority of the public school children is more striking than the graphs indicate. The difference can be stated in this way: A group of public school children, composed more largely of the inferior members of the school grades, outranks in the tests a group of parochial school children composed to a greater degree of average individuals.

Age—There is improvement from fourteen to fifteen in every phase of every one of the mental tests. The girls gain faster than the boys in the cancellation and substitution tests. Otherwise, the gains are about the same for the two sexes. In each case, the content of the test was changed the second year. In the cancellation test, the letter to be cancelled was changed; in memory the series of digits were all changed; in substitution the key was changed; in the sentences and opposites different blanks were used. While a general familiarity with the kind of thing required is doubtless an element in the improvement, it is not possible that it is sufficient to account for it all. Indeed, one might argue with as much plausibility that a memory of the previous performance, so much like the second one, and yet different from it, acted as an element of confusion which would tend to lower the level of the tests of the second year. The experimenters' judgment of the situation is that after the lapse of a year, the memories of the previous set of tests were not definite enough to play the part of an element of confusion, but that probably a general familiarity with the requirements, and with the personnel of the laboratory, was a small element in the improvement, while the greater part of it can be attributed to the added year of maturity. At any rate, this element of uncertainty in the interpretation of the results is one which is necessarily inherent in the re-testing of the same group of individuals in similar types of performance.

3. Theoretical Importance of the Grade Correlations

From the point of view of the present piece of research, the existence of consistent correlations with school grade throughout the tests is a matter of great importance. If the tests had failed to show such a correlation, there would have been no point in attempting to base on them comparisons of working children with school children. As it is, we can at least feel sure that the tests are capable of making the same kind of discrimination between superior and inferior ability that the school does in grading its children. There are, of course, critics of modern pedagogical methods who insist that this is saying very little, and who imply that in many cases it is the superior children who fail in school

because they refuse to submit to its stultifying régime. However, the fact remains, that at present the school furnishes by far the most general and reliable standard of measuring the ability of young people which we possess, and the general correspondence between the standards established by the schools and those of the tests is the strongest bit of evidence of their usefulness which we could hope to obtain.

4. Methods of Measuring Mental Development Above the Age of Twelve Years

The question as to whether tests of the type of the Binet-Simon Series, which would apply to ages from fourteen up, could be worked out, has been of widespread interest. The Binet-Simon tests are based upon the principle that success or failure in a definite performance is to be taken as the measure of an individual. The tests are devised in such a way that degrees of success or failure in any one performance play no part, and no account is taken of the factor of the time in which the task is accomplished. The universal experience with the tests seems to be that they give fairly satisfactory results up to ten or eleven years, but that above twelve years, at least, they are not satisfactory.

It seems probable that there are excellent reasons why there is an age limit to the usefulness of tests of the Binet-Simon type. The differences in individual capacity are much smaller among young children than they are among those approaching maturity, or among adults. In other words, the group of individuals which is to be considered normal, shows a much greater degree of uniformity at four, five and six years, than at fourteen, fifteen and sixteen. While it is comparatively easy to find a small set of tasks which one can say ought to be successfully performed by a normal child of six, but are a little too hard for a normal child of five, it seems hopeless even to look for a set of tasks which can be successfully performed by a normal child of sixteen, but are too hard for one of fifteen. The variations within the limits of what must still be considered normal are too large at sixteen,

and overlap too much with the ages before and after it to make that kind of discrimination possible. Standards of mental measurement for ages from twelve up of the type of those presented in this monograph seem much more feasible. They must be based not on a definite success or failure in tasks, but on a sliding scale of degree of efficiency with which tasks of a certain type are performed by individuals of each age. If one can see that the total scale for a large series of fairly normal individuals continues to move up from year to year, as it does, for instance, from fourteen to fifteen in the tests we have reported, then that particular type of performance can be employed as a measure of normal dvelopment for a given age. A boy, for instance, who displays a given rate of speed in the tapping test, can be classified as conforming to the median for fourteen years in rapidity of movement, but below the median for fifteen years, etc. An individual ranked in this way in a standard series of mental and physical measurements, ought to be accurately placed in comparison with other individuals of his age. The limit to this kind of measuring will depend upon the age at which differences in the scale of measurement disappear. In the case of rapidity of movement, for instance, we shall doubtless reach a point as the test is applied to older and older individuals, when our additional year of age fails to show a significant increase in the scale of rapidity. When such a point is reached we shall have to say that we have arrived at the adult measurement for that particular capacity. Doubtless some tests will continue to show a scale which rises consistently with age, for a much greater number of years than others. The problem before us now is to find out which those tests are, and of course what the normal scale for each age is.

Before leaving the subject of scales of measurement, it would perhaps be worth while to discuss briefly the element of timing, which is so prominent in this series of tests, and so conspicuously lacking in the Binet-Simon series. To base a distinction between individuals so largely on the difference in speed with which various tasks can be performed may at first sight seem beside the mark. In defense of it, however, we would point out

that in several of the mental tests, the most conspicuous difference between the children ranked by the school as superior and those ranked as inferior, was exactly this difference in the speed with which the task could be performed. There were very few children, for instance, who failed conspicuously in the substitution test. After having filled in three practice pages, the vast majority of them could fill in the fourth page with a comparatively small percentage of errors. If no account had been take of the time element, we should have concluded that this test was one which was not at all well fitted to distinguish between the superior and the inferior individuals. But when the element of speed is taken into consideration, we find a very large and significant correlation with school grade. Our experience in applying this test to individuals sent to us under suspicion of mental deficiency, bears out the same fact. Some of them were able to perform the test with fair success on the fourth page, but they required a far longer time—often more than twice the time, to reach the result.

When one considers the requirements of the business and industrial world, the emphasis given the time element seems quite justified. The difference between one stenographer and another is not at all that the good one can write a letter on the typewriter, while the poor one can't—or even that the good one can write it correctly, while the poor one can't. A certain degree of correctness is taken for granted. The large difference consists in the fact that the good stenographer can do her letters as correctly or more so, and at the same time faster than the poor one. The same holds true conspicuously of machine operating, or even of hod-carrying. In fact the whole modern movement for increasing the efficiency of business and industrial processes, is based on the idea of reducing the time in which a given operation can be performed. The fact that in our series of tests, the superior individuals showed their superiority so often in terms of speed may be regarded as a converse statement.

We believe, then, that the scales of measurement presented in this contribution constitute a good beginning in the task of estab-

lishing standards for fourteen- and fifteen-year-old children. It is because of our faith in their usefulness, that we have been so very explicit in giving directions for the application of the various measures. Very probably the addition of the measures of children who remain in school will change the scale somewhat in each measurement. In fact the comparison of our results with those of other observers (a comparison rendered uncertain, to be sure, by differences of method) seems to indicate that at least in physical development our working children are inferior to public school children as a whole. If we find the scales different for the group of school children, we shall arrive at a single scale for each age which is more fairly representative than those now presented, and shall also be able to state to what extent the two groups—working children and school children—depart from the general mean. There may, of course, be other tests which would serve the purpose of measurement even better than those we have employed. If so, their usefulness will have to be demonstrated, and their age standards established in much the same way.

5. Vocational Corollaries

Although, as we explained in the introduction, the important applications of the series of tests to vocational problems will come in a later publication, there are perhaps a few conclusions to be pointed out now. The positions open to children of fourteen and fifteen years who possess only the educational qualifications represented by the upper grades of the grammar school, are of very limited variety. Many of them require so little either of skill or of intelligence that not much selection of individuals need be made. Almost half of the boys, for instance, are employed in running errands. There are, however, a few factory positions requiring manual skill, and some simple office positions where selection is of importance. For these, the following conclusions can be drawn.

In employing children of fourteen or fifteen in positions where mere strength, mere rapidity of motion, or mere steadiness of the hand are concerned, the question as to how successful the child had been in school would not be important. One would stand

only a slightly better chance with a child who had a good school record. The question of sex would be more important. For positions requiring strength, or for mere rapidity of motion (particularly at fifteen years) boys would be better. For those requiring steadiness of hand, or fine motor control, girls would be better. In any positions in which rapid coördination to unforeseen stimuli were involved, any occupation of the sorting type, or the management of machines in which the process was not purely habitual, both school record and sex would throw light on the candidate. Children who had done well for their age in school ought to be given the preference over those who had not; and girls should be given the preference over boys. The employment of girls in such occupations as the sorting of balls for ball bearings, in telephone operating, and in type-writing, probably has a scientific as well as an economic basis.

In employing children for office work, even of a very simple routine type, their school records should be considered. Children who had done well there would stand a better chance of success than those who had done poorly. At fourteen there would be little point in giving a preference to either sex, but at fifteen girls are more likely to succeed.

If there were any occupations open to children at fifteen which required mechanical ingenuity, boys, should be given a large preference.

6. Physical Standards for Admission to Industry

There are very few instances in which any physical standards for the admission of children to industry have been adopted. The rule of the New York Board of Health that children of fourteen must be at least four feet, eight inches in height, and at least 80 lbs. in weight if they are to be granted working permits, is perhaps the most important instance of the application of a definite physical standard. The Department of Health of the City of New York cannot be too highly commended for having taken this stand on so important an issue. We merely wish to point out, that on the basis of our results, the minimum standards of height and weight for children of fourteen years of age, ought not to

be the same for the two sexes. The New York standard applied to our own series of 753 fourteen-year old working children would have excluded nine girls and twenty-seven boys—three times as many boys as girls. The New York department probably avoided this kind of injustice by the rule that any child who fell below the minimum standards of height and weight had the right of further physical examination, and might still receive his working papers if he proved thoroughly healthy in spite of his small size. A difference of standard for the two sexes, however, would obviate the necessity for some of these special examinations. For states which have a minimum age of fifteen years for entering industry, a sex difference in standards of height and weight would scarcely be necessary, since the differences at that age are much smaller than at fourteen.

It is possible that other factors of physical development in addition to height and weight may prove to be valuable guides for the acceptance or rejection of youthful applicants for admission to industry. Such a series of measurements as we have presented when interpreted in the light of subsequent industrial histories, ought to offer on this point valuable evidence.

UNIVERSITY OF MICHIGAN LIBRARIES

PART I

Introduction

Recognition has well been defined as that psychical process which makes a present state of consciousness appear to us as having already formed part of our previous experience.[1] Recognition, therefore, is midway between perception and recollection. It is related to the former in that it depends upon an external stimulus for its arousal; it is akin to the latter in that it is always accompanied by a consciousness more or less clear of a past relation between the ego and the object of present apprehension.

There is no fundamental difference between recognition and discrimination. Each of these terms refers to the same mental process looked at from different points of view. If recognition means re-cognize, to know again what has been known before, discrimination means to separate, to distinguish two contents of consciousness, one of which has been appropriated by the self, and is employed as a check or a foil upon the other. We recognize every time we discriminate, but we do not necessarily discriminate every time we recognize.[2] If the mind is suddenly and unexpectedly flooded by the feeling of likeness, we have recognition proper. If we know what to expect in perception and experience something that is different but generically related, we have discrimination proper.

The twofold nature of the mental state we are describing is neatly illustrated in the experience we have while waiting for a friend, or some one we know, at a railway station. As the scores of people come pouring out of the train, we scrutinize their faces and repeatedly form the judgment: This is not he, this is not he. The distinctness with which we form it is directly proportionate to the resemblance between the person

[1] D. Katzaroff, La Recognition; Archives de Psychologie, Vol. XI, p. 2.
[2] James, Principles of Psychology, Vol. I, p. 528.

we see and the person we are looking for. In this act we are noticing differences. We are separating that which is from that which we know ought to be. Suddenly our attention is arrested by a familiar form, the gait is familiar, the facial expression, the dress, in short, the total impression is one of general affirmation. We owe it to the fact that our lives are cast in a world which has uniformity and complexity, likeness and unlikeness combined in one that we are constantly called upon to use both recognition and discrimination in our daily life.

Because recognition depends upon an external stimulus for its arousal and because it is a consciousness of having experienced that stimulus before, recognition may be considered as both objective and subjective. But it is more of the latter than the former, since in the act of recognition the stream of consciousness seems to fold back on itself.

Again, recognition is either direct or indirect, immediate or mediate. When the former, it is a spontaneously induced mental state, completed without the conscious aid of any other psychic factors. When the latter, it is a slowly dawning state, depending upon mediating ideas, images and associations for its completion. Thus as I walk along the street of a strange city I suddenly hear my name called out. I look about, and recognize one of my intimate friends. The process is instantaneous, it is almost like direct apprehension, yet it is not that because there exists the consciousness of "I-know-you," or I have felt-you." In the words of Bergson, it is recognition without thought.[3] But again, I am sitting in a hotel lobby when a man comes up to me and greets me by name. I return his greeting, but I cannot "recollect" who he is. Rapidly I cast over in my mind the possible places where I could have met him. I call up the images of some persons whose acquaintance I recently made. But no, he is none of them. He probably sees my confusion, and asks me if I remember Blank Beach. My mind instantly flies thither. I call up a memory image of the beach named. I try to put myself into situations where I possibly

[3] Matter and Memory, p. 113.

could have been in his company. I now recall a boating party where I made several new acquaintances. Perhaps he is one of them. Why, yes; his face looks familiar when he smiles. His name begins with a vowel—with an A, I think. At this point he introduces himself to relieve me of my perplexity. The moment he mentions his name I grasp his hand. I feel a sense of relief. Of course I know him. He is the man who told me of his strange experience in Africa; and there is the scar on his forehead, showing where he had been wounded in a battle with some natives. Here we have recognition through intermediating facts—ideas, images, associations, and efforts of will.

We have sketched two extreme cases of direct and indirect recognition. But that does not exhaust the process yet. Recognition may further be distinguished with respect to mental complication. If it consists merely of an already experienced impression it is termed simple recognition. Most direct recognition is of this sort. If, on the other hand, it concerns the nature, importance and circumstance of the object, it is said to be complex, intellectual, or conceptual recognition. Most indirect recognition is of this sort.[4] Complex recognition may be either ideational or affective. As a rule it is a combination of the two. But if it is the former alone, it is accompanied and supported by visual, verbal or auditory images, by associations, reflections and inferences. If the latter alone, it is the embodiment of the feelings of familiarity accompanied by such other feelings as pleasantness, satisfaction, relief, fitness, appropriateness, or the reverse of these if recognition is uncertain.

The feeling of familiarity (Wundt's Wiedererkennungsgefühl, of Höffding's Bekanntheitsqualität), is the most fundamental factor in all forms of recognition. And it is because this feeling cannot be further analysed that recognition is called a primary mental quality. None of the attempts made to describe the feeling of familiarity have been especially enlightening. Wundt says it comes about from the assimilation of the sensory im-

[4] Katzaroff, *op. cit.*, p. 5.

pression with the corresponding image. It is independent, however, of the assimilative process itself, and is only stirred up by it.[5] For Höffding the feeling consists in the process of assimilation.[6]

Wundt further maintains that each separate act of recognition "possesses its own peculiar quality." Thus he says, "The feeling differs when we recognize our friend, X, and when we meet Mr. Y. whom we did not care to see again."[7] In each case the peculiar quality of the feeling of familiarity is a function of the object of recognition. Like all feelings, it is determined by "the influence of the ideational content of consciousness upon the apperception."

In reply to this, however, it might be said: (1) The different feelings of familiarity aroused by different objects may not be distinct feelings, but fusions of various feelings—the feelings of pleasantness or disgust, ease or strain, fulfillment or disappointment—which blend with each other and thus swamp the original and unique feeling of familiarity. (2) The recognition of geometrical forms, nonsense syllables and other objects that are devoid of ideational content, is invariably accompanied by the same and uniform feeling of familiarity.[8]

The theory advanced by Höffding in his famous controversy with Lehmann says that the feeling of familiarity is due to the fusion of two similar mental processes: one, 'A,' which is the perception of the object, and the other, 'a,' the image that the object had left behind when it was first perceived. According

[5] Introduction to Psychology, pp. 105-7.

[6] Vierteljsch. f. wiss. Philos., Vol. XIII, p. 432.

[7] *Op. cit.*

[8] Katzaroff, *op. cit.* See also Meumann, Bekanntheits- und Unbekanntheitsqualität; Arch f. d. Ges. Psychol. Vol. XX, p. 36. In this short, but well written article, Meumann makes an excellent distinction between the feelings of familiarity and strangeness. The former is characterized by a certain easiness with which the psychic processes—both organic and mental—flow; by a mild feeling of relief, satisfaction and pleasure; by little voluntary attention; and by the presence of reproduced memory images. The latter is characterized by a sort of inhibition or feeling of arrest which is both motor and mental; by the presence of a peculiar consciousness of inner emptiness; by a feeling of distress; and by the absence of imagery or associations.

to Höffding the image, 'a,' fuses with the percept, 'A,' and it is the blending of the two that gives rise to the peculiar feeling of familiarity. In some instances the coalition is rapid and complete, and so we have direct recognition with full certainty. In other cases the overlapping of 'a' with 'A' is only partial, or the superposition takes an appreciable length of time, and so we have indirect recognition accompanied with uncertainty or doubt.[9]

In reply to this view it may be said: (1) It has been demonstrated time and again that recognition can take place without the aid of mental imagery.[10] (2) Experiments have been made showing that even when the subject has a *distorted* image of the object perceived, he can recognize it accurately nevertheless.[11]

Claparède firmly believes that recognition does not depend on memory images. Very often a person, in describing an object he had formerly perceived, shows himself to be absolutely mistaken as regards its qualities—such as color, size and form; yet when confronted with that object he will recognize it immediately as the one he had seen before. "If recognition depended on mental imagery, then the distortion of the memory image ought to prevent correct recognition from taking place," concludes Claparède.[12]

Besides being simple or complex, recognition is also either implicit or explicit. Implicit recognition takes place when an object appears familiar to us, but we cannot locate it in our past experience, we do not know its setting. Such expressions as, "Your face looks familiar, but I don't remember when I met you"; or "That air sounds familiar, but I can't recall the opera from which it comes nor where and when I heard it"; or "That name sounds familiar, but I can't recall what the person looks like",—are all indicative of implicit recognition. That is to say, there is no doubt about the object having been ex-

[9] *Op. cit.*

[10] Gamble and Calkins, Die reproduzierté Vorstellung beim Wiedererkennen, etc., Zeit. f. Psychol., Vol. XXXII, 177ff.

[11] Claparède, Recognition et Moiité; Arch. de Psychol. Vol. XI, 89ff.

[12] *Op. cit.*

perienced before, but the connection, the circumstances are lacking. Explicit recognition, on the other hand, is where the object is fully known either in all or in most of its tangible relations to the time, place, setting and circumstances in which it was originally experienced. It follows, of course, that all direct, immediate recognition is explicit, whereas indirect recognition has to go through a stage of implicitness.

Finally, recognition is either voluntary or involuntary. Indirect recognition is usually of the former type, while all direct recognition is of the latter.

It is no exaggeration to say that recognition and its correlate, discrimination, are among the most active and valuable factors of our mental make-up, yet as compared with what has been written on other faculties, such as attention, memory and feeling, very little space has been devoted to our subject.

It is only within very recent years that psychologists have begun to investigate such problems as the relation between recognition and association;[13] the nature and cause of the errors of recognition;[14] the relation between recognition and the number of items to be recognized;[15] the relation between recognition and recall as well as the influence of different kinds of stimuli on these faculties;[16] and finally, the relation between recognitive ability and the time interval.[17]

Small showing, indeed, for what James calls "one of the ultimate foundation-pillars of the intellectual life."[18] For it must be obvious that the perception of likeness and unlikeness is the very bed-rock of consciousness. On it depends our knowledge of the unity of the self, as well as our knowledge of the uniformity of nature. In the process of mental evolution recognition follows perception and precedes ideation.[19] Suppose we

[13] Gamble and Calkins, *op. cit.*

[14] Katzaroff, *op. cit.*

[15] E. K. Strong, The Effect of Length of Series on Recognition; *Psych. Rev.*, Vol. XIX.

[16] H. L. Hollingworth, Recognition and Recall; *Amer. Jour. Psych.*, Vol. XXIV.

[17] Strong, Effect of Time Interval on Recognition. *Psych. Rev.*, Vol. XX.

[18] James, Principles of Psychology, Vol. I, p. 530.

[19] Sully, Outlines of Psychology, p. 142.

failed to recognize our friends and kinsmen, our homes and surroundings, our sensations and ideas every time they were presented to us; suppose every recurrent experience were a new experience—it is evident that our life from the cradle to the grave, if we could leave the former long enough to reach the latter, would be like that of the moth in the presence of the flame.

But recognition and discrimination are also operative in finer experiences than those we have had occasion to mention. We speak of "a subtle mind," "a fine sense of discrimination," of "ability to split hairs," and so on. What do we mean by these expressions? Certainly the recognition of a friend does not involve a fine sense of discrimination, but the comprehension of the relation between a falling apple and the revolving moon does. Yet these two mental activities differ from each other in degree only. Is not the entire process of reasoning essentially one of recognizing the relations among ideas, or among "things" as modern logicians like to put it?

"Inference," says Aikens, "is the *recognition*[20] of a new relation of things without which the relations asserted in the premises could not exist." Mathematical reasoning is chiefly reasoning by parity. In geometry, for example, each successive proposition is based on one or more preceding propositions. Success in the solution of geometrical problems, therefore, depends not only on a knowledge of the foregone propositions, but also on the faculty of discerning what theorems are applicable to the problem at hand. In short, the highest type of mental activity we can think of involves recognition and discrimination. Hence Locke is right in saying, "In having our ideas unconfused, and being able nicely to distinguish one thing from another where there is but the least difference, consists in a great measure the exactness of judgment and clearness of reason." And again, "Judgment . . . lies in separating carefully one from another ideas wherein can be found the least difference, thereby to avoid being misled by similitude and by affinity to take one thing for another."[21] Nor ought we to

[20] The Principles of Logic, p. 153.
[21] Human Understanding, II, XI, 1, 2.

omit James' estimate of this faculty. "Some people," he says, "are far more sensitive to resemblances and far more ready to point out wherein they consist, than others are. They are the wits, the poets, the inventors, the scientific men, the practical geniuses. A native talent for perceiving analogies is reckoned by Bain, and others before and after him, as the leading fact in genius of every order." [22]

We have now seen how recognition is defined; we have described some of its phases; we have illustrated in brief how it functions in life, and have noted how leading psychologists rate it in the order of human intelligence.

Let us now turn to our own investigation.

PRELIMINARY EXPERIMENTS

Statement of Problems

The preliminary experiments, undertaken in the fall of 1911, were chiefly for the purpose of devising means and methods.

Some of the problems I set out to investigate were as follows:

(1) What is the effect of distribution of attention on the recognitive process? Or in other words: How does the number of objects among which a thing if perceived and re-perceived affect recognition?

(2) How does recognition vary with the time of perception?

(3) What is the influence of similarity on recognition, and is there a mathematical relation between discriminative ability and degree of similarity?

(4) What is the difference between external and internal similarity, i.e., does similarity in form affect ideational recognition differently from similarity in meaning? It is well known that deception is not only sensory but also ideational.

(5) What is the difference between substitution (displacement of one object by another), and mere interchange of position?

(6) What is the influence of environment on recognition? Will a thing be recognized as readily when observed in a new

[22] *Op. cit.*

setting on the second exposure as when observed within the setting in which it was originally experienced?

Let us discuss these problems somewhat in detail.

Our experiments purport to investigate a representative cross section of the faculty of recognition. For that reason we tried to reinstate in the laboratory conditions that were analogous to those under which we perceive and recognize things in daily life. But not only must these conditions be representative of life situations, they must also be of such a nature that we can vary them quantitatively. For surely the average person's state of attention is different on a crowded thoroughfare from what it is on a lonely country road. Likewise the average woman's attention in the teeming department store is not the same as in the little village store. How can we reproduce these different forms of attention in the laboratory?

On the crowded business street, for example, a person's attention is constantly being distracted. Thousands of stimuli knock at the door of consciousness, and, as they are in a fleeting state and as the individual himself is moving rapidly, they can obtain but a very small fraction of his attention. But that is not all. Some of the things he perceives are more interesting than others; some are novel, others plain; some are familiar, others strange; some are pleasing, others displeasing; some set up thought processes, others do not. In short, with one sweep of the eye he takes in persons, vehicles, shop windows, signs, forms, names, colors, positions,—everything that falls within the periphery of his vision; not to mention the myriads of auditory sensations. Here is a very rich stream of consciousness indeed. How can the psychologist reproduce it in his subjects in the laboratory?

(1) Our own method was quite simple. If we simultaneously expose, let us say, 8 words of ordinary meaning for 4 seconds, and instruct our observer that he is to grasp those words well enough to be able to recognize some or all of them when they are re-exposed after a definite interval, we may rest assured that his state of mind will be quite representative of what it is on the crowded thoroughfare. As there, so here, some words, i.e., things, will be more interesting than others; some

UNIVERSITY OF MICHIGAN LIBRARIES

familiar, others strange; some rich in associations, others poor; and as the subject knows the exposure time is limited, he will hurry from one word to another, just as his attention is hurried from one thing to another on the street.

The introspection of my observers affirmed the correctness of our method in this respect. Their attention was not distributed in the sense that they perceived 6 or 8 words in one pulse of attention. In fact, it is doubtful whether such a distributed state of attention can exist.[23]

Wirth, who has done extensive work in this field,[24] did not obtain positive results. He found that within certain limits the spreading out of the attention over a number of simple objects causes a corresponding intensification of the attention with respect to each object. This, however, is no proof of a distributed state of attention. The very same thing is found with rapidly fluctuating or distracted attention. What, then, is the difference between the two? In distributed attention it is assumed that the same amount of attention is simultaneously given to each of several objects which enter consciousness; whereas in distracted attention, the attention is given more or less completely to one thing at a time. According to Hylan there is no distributed attention in the strict sense of the word. "Attention," he says, "really fluctuates and is not distributed."[25]

For our experiment it really makes no difference whether attention actually can be distributed or whether the phenomenon that goes under that name is due to the rapid fluctuation of attention. Suffice it that we were able to produce in our subjects the states of mind that they experienced on the city streets. Thus by exposing a group of disconnected words simultaneously for a brief space of time, and instructing my observers to perceive all of them with sufficient clearness to recognize them 20 seconds later or to note whether any one word had been

[23] J. P. Hylan, The Distribution of Attention, *Psych. Rev.*, Vol. X.

[24] Die Klarheitsgrade der Regionen des Sehfeldes bei verschiedenen Verteilungen der Aufmerksamkeit. Phil. Stud. II. Also Psych. Stud., Vols. II and III.

[25] The Distribution of Attention, p. 397.

displaced by another, they declared that they managed to read the words once, but they had a feeling of being hurried, like one who desires to see things on the street, but knows it is not good manners to stop and gaze, or that he has no time for that. Then, too, there was a decided rivalry of attention. That is, the subject having read one word went to the next, but immediately began to fear that he did not get the preceding one correctly, so that there was a tendency, a desire to look at it again, a sort of dragging back of the attention. This, however, was inhibited by the fear that if too much time were spent on one word, the shutter would go down before all words were read. And so he hastened on with the same feeling as the small boy who wishes to see the entire line of parade and at the same time to keep up with the head of it, too.

Now this is precisely the state we wished to produce. For, in the first place, it is characteristic of the normal and daily sort of attention, except when one is preoccupied of course; and in the second place, it really furnishes a means for giving the same amount of attention to each of several things which are complex in their nature—as all meaningful things are. When I say the "same amount" I mean the requisite or proportional amount. For unless the stimuli are of the simplest possible kind, such as pressure, or shades of gray, or pitch; unless they are measurable in terms of their own kind,—the same stimulus may not only require a different threshold for complete perception with different subjects, but stimuli of the same sort may differ from one another considerably in complexity.

This is the first serious error made by Bourdon [26] and Katzaroff,[27] the one using words, the other geometrical forms as stimuli in their experiments on the process of recognition. These authors thought that by exposing each word or figure for the same length of time, the whole of it would receive the same amount of assimilative attention. But that is not so. The words "rose" and "juste",—two words used for comparative purposes by Bourdon, do not necessarily possess the same amount

[26] Reconnaissance, Discrimination et Association, Rev. Philos. Vol. XL.
[27] *Op. cit.*

of interest to the same person. Therefore, it is wrong to assume that by exposing them for the same length of time they will become equally impressed on consciousness. Likewise with Katzaroff's designs: the drawing of a house and a meaningless, complex trellis-like figure,[28] each exposed for 6 seconds, will not produce the same impression on the mind. The former has meaning, the latter has not; the former is rich in associations, the latter is not; the former has distinct, conceptualized features whereby it can be carried in memory, the latter has none of these. Hence the different kinds of recognition these authors describe—recognition by general impression, recognition by remembrance of some special feature, recognition by association, etc., may all be functions of the object and not different phases of the recognitive process.

Thus, if we examine some of the introspection Katzaroff reproduces with reference to the figures sketched in his well-written paper, we find that those designs which had meaning attached to them were recognized or discriminated in meaningful terms; the others on the basis of general impression. To assume that groups of objects so diverse as Katzaroff's figures have the same attention value and make the same impression simply because each of them is exposed for the same length of time, is like assuming that it is as easy to recognize potatoes as presidents, because they both begin with p.

Of course, it may be retorted that Katzaroff was studying the process of recognition in general, and therefore he had a right to use both meaningful and meaningless material. Even if that be granted, it is still doubtful whether it was proper to lump together the results of such diverse material.

But there is another objection to the indiscriminate use of meaningful and meaningless material in experiments on recognition, and that is that the subject, though he succeed in recognizing the meaningless object or its substitute on the second presentation, is often at a loss as to how he should describe it, or how impart his knowledge. Thus an undue burden is put on the introspective memory, there is a sort of checking and

[28] *Ibid.*, p. 43, figs. 17 and 19.

hampering, confidence falls, doubt increases, and the observer either finds himself unable to judge at all, or else makes a guess judgment as the easiest way out. This is verified by the fact that when Katzaroff's observers introspect on the meaningless figures, they go about it in an indirect way and very often end in doubt. This is also the reason why the subjects in Moore's experiment on abstraction[29] found themselves unable to give a reason why certain figures looked familiar or strange.

In the experiments that form the basis of this paper, both of these sources of error have been avoided by employing uniformly conceptualized material, simultaneously exposed in definite groups for a definite length of time, and by allowing the subject to devote as much attention to each item as he felt was necessary, the only condition being that he perceive them all within the given time of exposure. And this, of course, he did because he never knew what word would be replaced. Hence, if he looked at some words twice and at others once, or if, when 8 words were exposed for 4 seconds, he did not look at each word for ½ second, but at some for 1 second, at others ⅓ second and at others still only ¼ second, it was, as introspection showed, because the former were somewhat unusual in his experience, whereas he felt he could never be deceived by the latter. Thus our technique once more showed its ability to stimulate, under experimental conditions, those factors of recognition that function in normal daily life. For, do we not, in actual life, when we wish to fix in our minds landmarks, signs, faces or what not, look at some a little "closer" than at others? But we shall revert to this later on.

(2) Not only do we usually look at some things closer than at others, but at some we also look a little longer than at others. Hence the second variable was the length of exposure. Besides keeping the fixation period constant and varying the number of objects exposed, I also kept the number of objects constant and varied the time of exposure.

(3) A third variable was the degree of similarity. In the

[29] The Process of Abstraction, Univ. of Calif. Publications in Psychology. Vol. I, No. 2.

UNIVERSITY OF MICHIGAN LIBRARIES

preliminary experiments I did not measure the degree of similarity, but as this is one of the main objects of our investigation, we shall leave the discussion of this factor to its logical place. In these early tests I procede on the assumption that there is some similarity between two words that begin or end with the same consonant, whereas there is no similarity, or zero similarity between words that do not begin or end with the same consonant, or do not have the same vowel sound. If this assumption were correct, then, other things being equal, the substitution of the former kind of a word ought to produce more false judgments than a substitution of the latter kind. Or in other words, suppose the conditions, with respect to length of exposure, and the number of words exposed, are such that the replacement of one word by another of zero similarity can be recognized 100 per cent of the times, then if there is any similarity between two words that begin or end with the same consonant, a substitution of one for the other ought to produce some false recognition.

(4) It is well known that diverse impressions may produce similar states of consciousness; therefore, if we employ stimuli that lack sensory resemblance but possess meaningful similarity, we can study the influence of similar ideas on one another, i.e., we can note the process of recognition within the realm of pure ideas. Then we can compare the results obtained with the two different sets of material and see whether our senses or our ideas deceive us most often.

(5) It was also our desire to find out whether a simple change of the position of two words within a list of a given size, would be recognized as easily as the removal of one word and the substitution of another for it. By this method we could determine whether recognition is stronger for content than for space relations, or vice versa.

(6) As the sixth factor—the influence of environment on recognition was not touched upon in the preliminary experiments, and as it forms an important part of the investigation, we shall defer its discussion at this point and take it up later on.

Method of Procedure

Since I was investigating ideational recognition and discrimination, it was imperative that I use meaningful material. To that end I employed, in these early experiments, bisyllabic words of ordinary usage, selected at random from the dictionary and varying in length from 5 to 7 letters. These words—nouns, adjectives, verbs and adverbs—were typewritten in small letters, on 3 x 5-inch plain filing cards. The words, triple spaced, were arranged in two vertical columns ½-inch apart. These typewritten cards came in pairs marked A and B on the back. The first was the 'standard' and the second (the variable) was a reproduction of the first with the necessary change affected.

Thus, if I wished to investigate the problem of imitation, i.e., the influence on the recognitive process produced by substituting one word for another similar to it in form, my cards would appear thus:

A		B	
pretty	justly	pretty	justly
hasty	early	hasty	early
improve	ledgy	impose	ledgy
kindly	glory	kindly	glory

If I wished to investigate the influence of change of position, card B would be a reproduction of A with the desired transportations made. Finally, the same card exposed twice, i.e. for fixation and trial, served as the control.

Apparatus

The apparatus used in this investigation was very simple. It consisted of a box-shaped screen, completely separating subject from experimenter. In this screen was an oval shaped aperture through which the observer looked with both eyes at the printed card, or at the picture post cards of the later experiments, exposed on a black background. The aperture was opened and closed by a shutter which moved vertically in grooves. This

UNIVERSITY OF MICHIGAN LIBRARIES

shutter was closed by two rubber bands attached to the lower end thereof and to the apparatus, while its opening was affected by means of a string secured to its top, running over a noiseless pulley and controlled by the experimenter.

This piece of apparatus was set on a low table so that the observer could look in through the opening conveniently while seated in a comfortable position.

The time of exposure, being one of the factors under investigation, varied with different series. The interval between the first and second exposure, however, i.e., between the fixation and trial, was kept constant throughout these and all succeeding experiments. This interval was 20 seconds.[30] It was not deemed advisable to make it longer, lest the minds of some of the observers should begin to wander. In that event we should have had recognition with mental concentration in some cases and recognition with distraction in others, and we should not know which is which. It was our desire to make conditions as uniform as possible for all observers.

I had six observers—five men and one woman—all of them graduate students and members of the Harvard Psychological Laboratory.[31] They came to me singly, once a week. All sittings were held between 9 and 1 o'clock, each lasting one hour.

I gave my subjects the following instructions: In daily life one is occasionally confronted with the phenomenon of mistaking one name or one word for another, because they have some resemblance either in spelling, sound or meaning. Now, I am going to expose a group of words for x seconds, and after an interval of 20 seconds I shall reëxpose the same group either intact or with some change. See if you can discover that change, and in your introspection at the end of the second exposure, tell me whether you carried any of the words in imagery, and if so, what kind of imagery it was, and how many you carried. Tell me whether you had any internal or

[30] I should like to have varied this factor also, but I had no time for that.

[31] I wish to offer my thanks to Miss O. L. M. Seeley, Drs. V. V. Anderson, R. M. Elliott, R. C. Givler, and Messrs. E. C. Tolman and I. W. Williamson for their patience, promptness and consistency while acting as my subjects.

external association, i.e., whether you associated some of the words in the group with each other, or with something extraneous to the group. Tell me what rôle, if any, imagery or associations play in the recognitions you make. Try to distribute your attention equally among all the words, i.e., do not concentrate your attention on some at the risk of failing to comprehend others. Try not to let your mind wander during the interval. Yet be natural, i.e., choose your own means for making the greatest number of correct judgments. In short, do your best, in your own way, to recognize a change if one occurs and tell me, if possible, precisely what that change is."

I made this last suggestion in order to reduce the element of chance as much as possible, for when 8 words are exposed and one of them is changed, the probability that the subject will guess the critical word as new is ⅛, but the probability that he will be able to couple with it the word it had displaced, by mere chance, is 1/64.

In the fore period I signaled my subjects to get ready about 2 seconds before the shutter went up. I did not give a similar signal before the second exposure because they had been advised to have their minds fixed on the experiment during the interval and to be prepared for the trial exposure. All forms of noise and distraction were avoided during the interval so as not to disturb the mental content of the observer. Exposure and interval were timed with a stop watch. The time it took the shutter to open or close was approximately ¼ of a second.

A correct judgment, "change" or "no change," according as one did or did not occur, was marked +, and incorrect judgment —, and a doubtful one, i.e. one whose certainty the subjects themselves rated as between 20 per cent and 79 per cent was marked ±, and given half value in the computation of the results.

Results

SERIES I

After putting my subjects through a period of training that lasted three weeks, I undertook to find out the minimum ex-

UNIVERSITY OF MICHIGAN LIBRARIES

posure time wherein, with a given number of words to the group, the substitution of one word for another totally unlike in form and meaning would be recognized 100 per cent of the times. I found that when groups of 6 words were exposed for 5 seconds, the replacement of the words

(A) broken, wander, career, native, patent
by (B) simply, return, winter, extent, always } Case I

respectively, and

(A) couple, revolt, beyond, lesson, beacon
by (B) hoping, money, assume, motive, voters } Case II

respectively, and

(A) parish, shiver, latest, insert, retort
by (B) devote, rocken, hockey, chosen, demand } Case III

respectively, gave the following per cent. correct judgments:

Case I = 92%
" II = 98%
" III = 96%

calculated on the basis of 30 judgments in each case. These figures are sufficiently close to 100% to justify the acceptance of these conditions as affording perfect discrimination for totally dissimilar words.

What would happen if, instead of substituting wholly unlike words, I substitute words that bear some resemblance to the standard ones?

SERIES II

To answer this question was the purpose of the next experiment. To make the answer conclusive, however, it was necessary to keep all the conditions of the first experiment intact, i.e. not only was it essential to use 6-word groups exposed for 5 seconds, but it was imperative that I employ the very same norms, the same settings and the same observers. Here was a difficulty, for my subjects would surely recognize some of the groups, and they might even detect the words that had been

replaced on the previous occasion and thus make an effort to memorize them on the first exposure in these comparative tests. But inasmuch as I was proceeding on the assumption that similarity interferes with discrimination, I allowed this factor to stand because, if anything, it would militate against my theory and not in favor of it. Hence, should I on this second occasion obtain lower percentages than on the first, my results would have all the more value.

Therefore, after an interval of one month, using the same groups under precisely the same conditions, I replaced the words

(A) broken, wander, career, native, patent
by (B) battle, window, coming, notion, police } Case I'

respectively, and

(A) couple, revolt, beyond, lesson, beacon
by (B) control, remove, belong, letter, better } Case II'

respectively and

(A) parish, shiver, latest, insist retort
by (B) parlor, shower, lowest, insert, report } Case III'

respectively, and obtained the following per cent. correct recognition based on the same number of judgments as the former percentages:

Case I' = 90%
" II' = 94%
" III' = 91%

The differences between the first and second sets of figures are not large. But if one bears in mind that the observers found nearly all the groups familiar this time, and that because of this familiarity they were able to carry more words by rote memory during the interval, one will have to admit that the substitution of one similar word for another does tend to inhibit recognition.

Now it will be asked why do I divide these words into cases I, II, III, and I', II', III'? The answer will be found by examining the words under each of these latter cases, first, with

respect to those in the former ones, and then with respect to one another. The words in case I' have one critical letter in common, those in case II' have two initial letters in common, and those in III' have three or more symmetrically arranged identical letters in common. Hence each of the primed cases differs from each of the unprimed ones in absolute amounts of similarity, while they differ from one another in proportionate amounts. Therefore, if our theory is true, then the per cent of correct recognition ought to vary inversely as the degree of similarity. Now this is true with two of the primed cases. The reason why case I' is lower than either II' or III' is probably because some of the groups that fell within it were difficult to grasp or especially confusing. This is substantiated by the fact that in series I the analogue of this case, i.e. case I also stands lower than either of the other two.

That this is the true explanation is substantiated by the introspection of my observers. Some groups lent themselves to internal associations better than others; of some the words could be carried in memory during the interval more readily than of others. But the most important thing for us to notice is that the per cent correct recognition for each of the primed cases as compared with the corresponding unprimed ones is lower. Now the only way the former differed from the latter is that their variables possessed some symmetrically arranged letters in common with the standards. Otherwise the conditions were identical: case for case the setting was identical, the norm was identical, the observers were the same and so was the time of exposure. Only one circumstance is different, namely, in one instance the variables bear no resemblance to the standards, in the other they do. Therefore, this resemblance must be the cause of the diminution of recognitive ability.

SERIES III

In order to obviate the necessity of performing two parallel tests—with and without similar words—it was deemed advisable to have the critical words within the same series vary uniformly in degree of similarity. But how is that similarity to be deter-

mined? One way is to resort to the judgments of competent persons, as Thorndike did in the construction of his handwriting scale.[32] This was done in another connection, as we shall see in due time, but in these preliminary experiments I decided to rate each pair of critical words on the basis of the number of symmetrically arranged identical letters which they possessed in common. If the scale of similarity thus established has any objective validity, then it ought to be made manifest by the recognitive ability of the subjects; i.e. the sum of all correct judgments rendered for the words of lowest similarity, ought to be higher than the sum of all correct judgments rendered for the words next higher in the scale of resemblance. The inverse relation should always hold. This is precisely the result obtained in this series as the following table shows:

TABLE I
6-word Groups Exposed for 3 Seconds.

No. Com. Let.	0	1	2	4	5	6
% C.	100	100	91	83	83	50
No. Judgments	8	12	12	12	18	8
% P. K.	100	90	90	100	100	75

The figures 0, 1, 2, 4, etc., in the first horizontal line indicate the number of symmetrically arranged identical letters that the critical words possessed in common. The next line shows the per cent correct recognition (% C) when such words were substituted for each other. The third horizontal line gives the number of judgments upon which the percentage is calculated. The fourth line (% P.K.) shows the per cent of perfect knowledge regarding the substitution, i.e. it shows the per cent of times that the observer was able to tell what word had been displaced every time he recognized a new word.

At this point I wish to forestall a certain objection that might be made. It might be said that the inverse relation shown to exist between degree of similarity and discriminative ability is inconclusive, because the separate percentages are based on altogether too few judgments. This objection would bear weight if it were not for the fact that in spite of the fewness of our cases the odds against such an alignment of % C as shown in

[32] Handwriting, Teachers' College Records, Vol. XI, No. 2.

Table 1, occuring by mere chance, are very great. If I had attempted to find out how 6-lettered, bisyllabic words which have two symmetrically arranged letters in common, let us say, affect recognition, and, on the basis of only 12 judgments, declared that such words can be recognized 91 per cent of the times, or that their coefficient of confusion is 9%, then the objection would be valid. Because that would be like trying to determine the percentage of a metal in a given alloy, which contains four or five kinds of metals, by making only one analysis. That would not be right. The proper way for the chemist to proceed in such a case is to make two or three analyses for the required metal, and if his results agree each time or are approximately close to one another, he is sure of their validity. That is one way of obtaining certainty. But the chemist may employ another method. Instead of making three or four analyses for the required metal, he may make one analysis for each of all the constituents of the alloy, and if the percentages of the different metals yield a total of 100%, then he is just as sure of the correctness of each separate result as he would have been if he had made three or four tests for one metal alone.[33]

Likewise with our problem. Suppose we state it in this form: Given five pairs of bisyllabic words which differ from one another uniformly in the number of symmetrically arranged letters that they possess in common, what is the probability that these words will produce confusion in the recognitive process in a uniform inverse relation on the basis of chance? Our answer is this: Suppose these critical words fall into five distinct groups determined by their critical letters, then the chance that words of a definite degree of similarity will be recognized the greatest number of times is ⅕, because they might have been recognized next to the greatest number of times, or third to the greatest number of times, or fourth or the least number of times; and the same is true of words of any other amount

[33] We assume that the several methods of analysis for the several metals are equally valid and equally easy of application. Actually this is seldom the case, but the practical difficulties do not militate against the logic of the argument.

of similarity. Therefore, the probability that these words which differ from one another in five distinct ways will be uniformly discriminated in an inverse manner by mere chance is $(\frac{1}{5})^5 = \frac{1}{3125}$ Or the odds against such chance occurrence, with the minimum number of judgments necessary for calculation of percentages, are 3124 to 1. It is highly improbable, therefore, that the results in Table 1 would be due to chance. Hence, there must be a causal relation between degree of similarity and ideational recognition.

SERIES IV

In this series I attempted to find out the effect of transposing words within the same group—not displacing them. Six-word groups were employed, and the time of exposure was reduced to 2 seconds.

TABLE 2

Per Cent Correct Recognition when two Words were Interchanged within Groups of 6 words Exposed 2 Seconds.

No. Com. Let.	1	2	5
% C.	63	61	42
No. Judgments	12	30	12
% P. K.	100	87	88

My next step was to use larger groups exposed for longer periods. I commenced with 10-word groups exposed for 10 seconds. A comparative test was made among the following factors: (1) substitution of words of varying degrees of similarity; (2) transposition of two dissimilar words within the same group; (3) substitution of words of internal similarity. The environment or setting was new with each pair of critical words.

Table 3 shows the results of the first factor. It is apparent that the conditions of the experiment were not ideal. If they had been, we should have obtained more than 80% C. when the critical words had no letters, or O letters in common, and we should also have obtained more than 84% C. when the critical words were identical throughout. Whether the disturbing influence was due to the number of words exposed or to the length of exposure is difficult to say. But though the con-

ditions under consideration permitted about 18% error, the general results are by no means affected, for this amount of error would have distributed itself over all the words in the series, i.e. it would have entered into the words of each degree of similarity in definite proportion.[34]. Hence, the figures in Table 3, which show the inverse relation between degree of similarity and recognitive ability, are just as conclusive as they would have been if the conditions of the experiment had been ideal.

TABLE 3

Per Cent Correct Recognition for 10-word Groups Exposed 10 Seconds.

No. Com. Let.....	0	1	2	3	4	5	6	Identical
% C.	80	..	90	76	74	54.4	46	84
No. Judgments	30	..	12	12	30	30	18	18
% P. K.....	63	..	100	43	93	93	80	

On transposing two totally dissimilar words within the same group, the change was noted in 62.6% of the cases. This calculation is based on 78 judgments. Obviously it is just as difficult to recognize the interchange of two words within a 10-word group as it is to discriminate one 6-lettered word from another when both have 4 or 5 symmetrically arranged identical letters in common.

We turn now to a consideration of the third factor—the discrimination of words of internal similarity. The material used in this instance consisted of 14 pairs of synonyms of two syllables, selected at random from Webster's International Dictionary. Each substitution was judged by five subjects[35] and out of a total of 75 trials, 63.7% were successful. It would appear then that the substitution of one synonym for another is just as difficult to detect as the interchange of two dissimilar words within the same group, or, as the substitution of one word for another both of which have between 4 and 5 identical letters in common.

But I refused to remain satisfied with this "average" result, and the chief reason is that there was considerable difference in the % C. of some of these synonym-substitutions. On asking myself what this might be due to, I could find no other verifiable

[34] This problem is discussed mathematically on pp. 36-39.

[35] One observer had to withdraw.

answer but that there might be a difference among the synonyms in degree of propinquity.

I had no objective standard whereby to measure the similarity of the synonyms. At first I hoped to find some scale of measurement by noting the serial order in the dictionary, in which one word appeared as a synonym of the other; but this order was reciprocal for only two of the fourteen pairs of words chosen. I therefore decided to classify the nearness of the synonyms by resorting to a large number of judgments. I established three classes or orders; into the first went those synonyms that were closest in similar meaning; into the second, the next closest; and into the third, the least closest.

The 14 pairs of synonyms were printed in two vertical columns. The list was given to each of 12 persons, with the instructions to judge the words in pairs on the basis of likeness in meaning, and to distribute them into the three groups mentioned above. When each individual had finished judging he was engaged in conversation for two or three minutes so as to eliminate from his memory all recollection of the values rendered. Then the same list, with the columns reversed was handed to him for a second valuation. This interval was not too short, because all the men declared that on going over the second list they did not remember any of the previous judgments, except the one rendered for the first pair of words.

The twelve men who judged the synonyms for me in this way were graduate students. Five of them were specializing in English, the other seven were men of high intellectual ability. From these twelve men I obtained 24 judgments for each pair of words. If we number these pairs 1, 2, 3, ... 14, and represent the classes into which they were placed by the Roman numbers I, II, III, we get the following table.

TABLE 4

Degree of Propinquity of Synonyms and Frequencies for Each Pair of Synonyms

Class	1	2	3	4	5	6	7	8	9	10	11	12	13	14
I	7	5	4	12	13	7	0	10	1	14	0	1	6	0
II	6	10	5	12	10	8	13	6	8	6	8	14	10	7
III	1	9	15	0	1	9	11	8	15	4	16	9	8	17
Av.	1.3	2.1	2.5	1.5	1.5	2.1	2.5	1.9	2.6	1.6	2.7	2.3	2.1	2.6

The manner in which most of the 12 subjects estimated the synonyms was to see how each member of a given pair would function in the same context. If the words could be interchanged in a given sentence without violating good usage, they were put into class one; if not they were put into one of the other classes. This is the reason why some of the words were put into a different class on the second reading from the one to which they were assigned on the first. Thus, one of my subjects gives the following reason for changing his judgment with the words "acquire-obtain."

"When I looked at the words in their first order, "acquire-obtain," I associated a noun with the first word so as to make sense, I said, "acquire-fame." Then I replaced "acquire" by "obtain" to see if it would make as good sense, and when I saw that "obtain fame" did not sound well, I considered the words to be unfit for the first class, and so put them into the second. But when I looked at the words in the reverse order—"obtain-acquire," I associated the first with the word "wealth," and when I replaced the first by the second and saw that "obtain wealth" and "acquire wealth" hang together equally well, I put the words into the first class."

Some of my judges being more critical than others, would try five or six different settings before giving their final judgment.

Having classified our synonyms on the basis of internal similarity, we are in a position to see how they influenced the processes of recognition. This result is shown in Table 5. The figures in the first column represent the order in which the synonyms were judged for their similarity, they correspond, of course, to the numbers 1, 2, 3, ... 14 of Table 4. The second vertical column contains the synonyms themselves, those under N being presented on the first exposure in the recognition tests, and those under V being substituted for the N's on the second exposure. The third column contains the similarity value calculated on the basis of 24 judgments. Column four shows the per cent correct recognition when the substitution was made. The other two columns explain themselves.

TABLE 5

Degree of similarity and per cent correct recognition when synonyms are substituted in 10-word groups exposed for 10 seconds.

Class	Word No.	V	Substituted for	N.	Degree[36] of Sim.	% C.	Av. Sim.	Av. % C.
	1	tumult		uproar	1.3	66		
I	4	protect		defend	1.5	70	*1.5*	*54*
	5	obtain		acquire	1.5	10		
	10	usage		custom	1.6	70		
	8	compute		reckon	1.9	42		
II	2	maxim		axiom	2.1	33	*2.1*	*61*
	6	afraid		timid	2.1	90		
	13	except		unless	2.1	80		
	12	provoke		excite	2.3	83		
	3	ordain		appoint	2.5	100		
III	7	outrage		insult	2.5	80	*2.5*	*72*
	9	disguise		conceal	2.6	50		
	14	busy		active	2.6	60		
	11	correct		improve	2.7	58		

The foregoing figures, especially those in the last two columns, again point to the fact that ideational recognition varies inversely as ideational similarity.

It may be interesting to ask just how one similar idea replaces another in consciousness and forces its own acceptance in place of the other, like some carefully disguised pretender? When the word "depend," let us say, is exposed among 9 other words for 10 seconds, the subject gets an ideational impression from it, which he either succeeds or does not succeed in associating with other ideas, and which he either does or does not carry in memory during the 20-second interval between the first and second exposure. As a rule my observers seldom carried over, from the first to the second exposure, more than 4 or 5 words, by rote memory. Not knowing what word would be replaced or if any replacement would occur at all, he looks at the group on the second exposure in a searching manner. Each of the repeated words, i.e. the words constituting the milieu, seems to "fit in." Finally he comes to the substituted word "protect". Now somewhere in the margin of his consciousness is the idea, not the word, but the idea "defend." Well, "protect" seems to express that idea so perfectly that he accepts it as the word which had induced the idea in the very beginning. Or suppose

[36] The lower numbers stand for closest similarity.

the sight of the substituted word "protect" calls the word "defend" to the foreground of consciousness, or better still, suppose the observer even carries over "defend" from the first to the second exposure; yet nevertheless, because "protect" is so close to it in meaning, he will begin to hesitate, wondering whether "defend" did not creep into consciousness surreptitiously, or suddenly come up by association, and he will oscillate between the two words, often declaring that "protect" is the word he saw on the first exposure because "it fits in." Indeed, this was an expression frequently used in describing a word that was recognized as the "same"—"it fits into consciousness," or, "it fits in with the rest," or, "it arouses the same idea," or, "it fits in with the image I had of it," or finally, "the idea produced by this word fits in with the state of consciousness that is reproduced by the other words."

If we now bring together the results of these preliminary experiments, we note the following facts:

(1) Under the given conditions of the experiment the transposition of two dissimilar words within the same group is approximately equivalent to the substitution of one 6-lettered word for another, both of which have 4 or 5 symmetrically arranged identical letters in common.

(2) The substitution of one synonym for another of the first order is equivalent to the substitution of one 6-lettered word for another, both of which have 5 symmetrically arranged identical letters in common.

(3) The substitution of a synonym of the second order for another is equivalent to the substitution of 6-lettered words which have between 4 and 5 letters in common.

(4) The substitution of a synonym of the third order for another is equivalent to the substitution of 6-lettered words which have 4 letters in common.

(5) There is an inverse relation between degree of similarity and recognitive ability.

Individual Differences

The individual differences among the observers can best be shown by the per cent distribution of their judgments. The

following table gives the results with respect to the absolutely correct (+), the doubtful (±), and incorrect (—) recognitions.

TABLE 6

Per cent Distribution of Judgments

Subjects	+	±	—
An.	51	13	36
Wi.	54	6	40
El.	64	9	27
Gi.	69	11	20
Se.	69	15	16
To.	74	9	17
Av.	63.5	10.5	26

PART II

The Quantification of Similarity and Recognition

The encouraging results obtained from the foregoing method of classifying our material—a material which at first sight would appear to lend itself least of all to measurement—justified the extension of this process in a more refined manner. If words that differ from one another in the number of commonly possessed symmetrically arranged letters, have their specific influence on recognitive ability, why can we not measure the similarity of these words in terms of per cent, and then see what relation exists between any given per cent. of verbal symmetry and recognition? This is our next task.

Peters in his experiment on Association by Similarity [1] made at attempt to measure verbal similarity in terms of per cent. But he used nonsense syllables, hence his task, which consisted merely in taking the mathematical ratio of the repeated consonants or sounds in two such words to the total number of consonants or sounds in those words, was much simpler than ours, inasmuch as he did not have the meaning element to contend with.

Thus he declares, "Roughly speaking, one might say that the presented syllable in which one out of three sounds is changed, shows a difference of 33% from its prototype."[2] By increasing the number of letters or sounds in his words he was able to make finer changes still. For example, the change from "gafum" to "mafum" = 20% difference; from "kugös" to "fulös" = 40% difference; and from "gaafes" to "raaful" = 60% difference—there being changes of 1, 2, 3 sounds respectively in a total of 5.

The same author also found that whether a change is made at the beginning, middle, or end of a word the effect on

[1] Über Ähnlichkeitsassoziation, Zeitsch. f. Psych. Vol. LVI.
[2] *Op. cit.*, p. 188.

reproduction is practically the same. The average per cent of false and zero cases resulting from change of the first consonant was 34%; of end consonant, 33%; of vowel, (middle letter), 36%.

The similarity of two conscious contents consists in their possession of common elements. The two perceptions abcd and abmn appear similar because they have the same sensation element—ab.[3] Likewise such two words as "brook" and "brown," for example, appear similar because they have the sensation element "br" in common. And this statement is made notwithstanding their totally unlike meaning. The most conspicuous physical aspect about words is their sound. But since even this depends on the arrangement of the letters out of which a given word is constructed, we must modify our statement and say that the most conspicuous physical aspect about words, whether written or spoken, is their alphabetical structure. It is quite possible, therefore, to measure the absolute similarity of words regardless of what their meaning, form or sound may be under special conditions. In the main, all these factors function together.

With this assumption I proceeded to measure the psychological similarity of 40 pairs of words which I had selected from the dictionary. These words differed in symmetry from 0 to 100%. That is to say, words which had no symmetrically arranged letters in common were given the arbitrary value of 0%S (S = similarity). Words like "roadside" and "germinal" would fall into that group. On the other hand, such words as "holiness" and "holiness" being identical throughout, were called 100% S. Now between these two extremes were pairs of words that differed from one another successively in the commonly possessed, symmetrically arranged letters. Some had the first two letters in common, others the first three, others still the first four, and so on, up to those that had all but the last letter in common. These words were tri-syllabic and of the same length—each being composed of 8 letters. This length was chosen because I wanted to construct an 8-unit scale of in-

[3] Peters, *op. cit.*

creasing similarity. It was my aim to build a 10-unit scale, but I could not find a sufficient number of words of the proper length and homogeneity to enable me to do this.

The 40 pairs of words were therefore divided into 8 equal groups on the basis of the difference above mentioned. This measurement of the words was, of course, wholly arbitrary. Whether the mathematical values assigned to them expressed their actual similarity I did not know. So it was deemed advisable to make a comparative test by having the words judged for similarity by a large number of individuals in the same way as the synonyms mentioned on page 23 were judged.

The words were typewritten in pairs horizontally, thus forming two vertical columns, and handed to each of 35 university men and women with the request that they estimate their similarity in terms of percentage. The average and mean variation of these 35 judgments were then calculated with respect to each pair of words, and said average was denominated as the psychological similarity (P.S.) in contradistinction to their mathematical similarity (M.S.)

The following list contains a representative word from each of the eight sub-groups. The numbers preceding the words show the order in which the latter were judged. Those under N were the "norms" in the recognition tests, to be mentioned presently, those under V were the variables.

Order of presentation both for valuation and recognition.			Comparative Similarity		
	N	*V*	% P.S.	M.V.	% M.S.
2	CULLENDER	SOCIETY	0	0	0
4	LIBRETTO	LINOTYPE	25	16	25
7	SEDULOUS	SEDITION	45	19	37
14	ILLUSION	ILLUMINE	52	13	50
8	MUTINOUS	MUTINEER	73	15	62
11	DISPOSAL	DISPOSER	77	9	75
13	SENSIBLE	SENSIBLY	86	7	87
5	HOLINESS	HOLINESS	100	0	100

The following table contains the results of the psychological judgments rendered for each pair of words. The numbers in heavy type at the head of each vertical column represent the mathematical similarity (% M.S.) of the words within that column. The figures directly underneath represent the psy-

chological values assigned to each pair of words which are indicated by the small numbers to the left of the column, under W.

TABLE 7

Per Cent Psychological Similarity of Each Pair of Words Based on the Judgments of 35 Individuals.

% M.S. = 0		25		37		50		62		75		87		100	
	W		W		W		W		W		W		W		
2	0	4	25	7	45	6	43	8	73	11	77	3	81	5	100
9	0	15	40	16	30	14	52	18	38	20	77	13	86	12	100
17	0	27	20	25	35	21	66	24	82	26	81	22	86	19	100
29	0	35	22	32	25	31	40	28	46	33	85	44	73	30	100
39	0	42	32	37	23	43	37	36	75	40	70	46	84	38	100
Av. % P.S.=0			*28*		*32*		*48*		*63*		*78*		*82*		*100*

The average psychological similarity (Av.% P.S.) of the words within any group corresponds sufficiently close to the mathematical value of the same group to justify the method of classification employed.

We have now ideational material that is uniformly graded—conceptualized stimuli that differ from one another in absolute units. Our next step was to find out what influence these measured stimuli have on the recognitive process. To this end each of the critical words was typewritten in capital letters on 3 x 5 in. plain filing cards, together with 7 other words of the same length called "fillers." These cards came in pairs, as the following figures show. The position of the critical words varied with different pairs, but was kept constant with each pair.

There were three kinds of word lists: (1) Those comprising the critical words that varied between 0 and 87% S inclusive. In this case the setting was identical with the two members of each pair, but differed from pair to pair. (2) Those that were 100% S with the exposure made in the same setting both times. (3) Words that were 100% S but exposed in totally dissimilar settings the first and second times. Here it was my desire to see what effect the perception of the same thing in a new environment would have on recognition. We shall note, later on, that this last factor has considerable significance for theoretical as well as for applied psychology.

SAMPLES OF WORD-CARDS

FIG. I

45 A: 0%S

ENERGIZE	EXAMPLE
FOLLOWER	GERMINAL
HARDENED	IMPOSTER
INTERVAL	LIQUIFY

45 B: 0%S

ENERGIZE	EXAMPLE
FOLLOWER	ROADSIDE
HARDENED	IMPOSTER
INTERVAL	LIQUIFY

FIG. II

11 A: 75%S

DIFFICULT	ASSISTANT
REGISTER	INSOLENT
LIBERATE	DISPOSAL
ADVOCATE	GASOLINE

11 B: 75%S

DIFFICULT	ASSISTANT
REGISTER	INSOLENT
LIBERATE	DISPOSER
ADVOCATE	GASOLINE

FIG. III

5 A: 100%* in N.E.

RECORDER	PLAINTIFF
RECENTLY	REGISTRY
REGIMENT	SACRIFICE
PARABLE	REMEDY

5 B: 100%S in N.E.

SCIENTIST	MOBILIZE
MODESTY	OFFERING
MODERATE	OFFICIAL
PARABLE	PANOPLY

* N. E. = new environment; 'A' was the standard card, 'B' the variable.

These typewritten cards were then taken into the laboratory, and each of them exposed for 4 seconds. The interval between the first and second exposure of each pair was 20 seconds; that between any two pairs varied from 2 to 4 minutes, depending on the time it took to record the introspection. The order of presentation was the same for all observers.

The exposure apparatus was similar to the one already described, only much simpler. It consisted of a vertical cardboard screen which separated observer from experimenter completely. A drop shutter, controlled by a string running over a pulley, moved up and down, opening and closing a 6 x 6 inch window. Within 3 inches of this opening lay the printed card on a slightly inclined black background. The distance of the card from the observer's eyes, when he sat in a comfortable position, was about 12 inches. The time that the shutter occupied in opening or closing the window was approximately ¼ sec.

For this set of experiments I had four subjects—one woman and three men.[4] All of them were trained psychologists and

[4] My thanks are due to Miss O. E. Martin, Dr. C. E. Kellogg, Mr. H. E. Burtt, and Mr. W. M. Marston who were my subjects on this occasion.

thoroughly experienced in the kind of observation needed in this investigation, having been my subjects in the recognition of picture post cards—of which more hereafter—for three months previous to these tests.

I gave them the following instructions: "I am going to expose a group of 8 words for 4 sec. I want you to look at all the words carefully. Try to assimilate them. Yet do not dwell on one word at the expense of others, but try to distribute your attention over all of them equally. After the first exposure there will intervene a period of 20 sec. during which you must try to keep your mind fixed on the experiment. After this interval the shutter will go up and again remain open 4 seconds. Look at the second card and see if it differs from the first. In the second exposure there will exist four possibilities; either all the words may be changed,[5] or all but one, or none may be changed, or only one. See which of these events occurs. And if you discover a change, tell me what it is, i.e. tell me not only what word you think is new, but also what word you think it has displaced. Note everything that goes on in your consciousness."

It should be obvious to the reader that I used words of 0% S and "identical" groups as controls in this experiment. For before I could establish a relation between degree of similarity and recognitive ability, it was necessary to find those conditions which (with the exposure of the largest number of items for the shortest possible time), would, on the one hand, yield 100 per cent correct discriminations when an object of 0% S was substituted, and, on the other hand, yield 100 per cent. correct recognitions when an object of 100% S was exposed, i.e. when no change was made at all.

The present condition—8 objects exposed for 4 seconds—did not give such ideal results; but as the aim of the investigation is to find that combination of t and N (t = time of exposure,

[5] Actually I did not have cards on which all the words were changed, but it is advisable to have such.

N = number of objects exposed), that would give those kinds of results, we shall return to this problem presently.

Table 8 contains the results of the recognition tests carried on with these standardized words. Comparing % C with % S we note that as similarity increases, recognitive ability decreases. This may be called the first law of recognition. The only criticism that might be made is that I did not have enough observers in this set of experiments. But the results harmonize so well with those obtained from seven observers using similar material,[6] as well as with those obtained from ten subjects in the picture post card tests,[7] that they cannot be due to chance.

TABLE 8

Relation between Degree of Similarity and Recognitive Ability given in terms of Per Cent, when Words are Exposed in Groups of 8 for 4 Seconds.

% M.S. =	0		25		37		50		62		75		87		[1] 100		[2] 100 N.E.	
	W	%C	W	%C	W	%C	W	%C	W	%C	W	%C	W	%C	W	%C	W	%C
	2	87	4	100	7	75	6	75	8	37	11	37	3	75	10	50	5	50
	9	87	15	87	16	50	14	13	18	38	20	25	13	0	23	100	12	100
	17	87	27	83	25	87	20	50	24	[0]	26	13	22	13	34	100	19	50
	29	100	30	100	32	75	31	50	28	38	33	0	44	37	41	75	30	75
	39	100	42	50	37	87	43	75	36	87	40	[100]	46	0	48	88	38	63
	45	87															47	100
Av.% C =	91		84		75		53		40		35		25		83		73	
Corrected results	100		90		80		56		42		35		25		0			

[1] These were the identical groups presented in both exposures.
[2] In the second exposure only one of the words from the previous list appeared in a totally new environment. For meaning of "corrected results" see discussion that follows.

Let us now analyse the results of table 8. In the first place, it will be noticed that when a substitution of 0% S. was made, only 91% of the judgments were correct, i.e. the observers failed to recognize such substitution in 9% of the cases. On the other hand, when the identical group was re-exposed, they declared in 17% of the cases that one word was new. We see, then, that in one case there is a tendency of 9% to say that a thing is the same when it is absolutely different; in the other case there is a tendency of 17% to say that one of 8 things is different when all are identical. How shall we interpret the results for the intermediate values of S. in the light of these

[6] See p. 24.
[7] See p. 86.

errors? As we have said on a previous occasion, these errors, if such we may call them, do not affect our general conclusion, namely, that there exists a simple inverse relation between degree of similarity and recognitive ability, because they enter proportionately into the judgments rendered for each unit of the scale. But inasmuch as it is our desire to discover the exact relation between any particular amount of similarity and recognitive ability, we must see in *what* proportion these errors distribute themselves throughout the entire scale.

We note that where the second exposures were identical with the first, the subjects declared that there was a change, 17% of the times. Does this mean, then, that the judgments of "change" rendered in those cases where a change actually occurred are 17% too high? No. For suppose this index to represent the tendency to make chance judgments of "change" with respect to any one of 8 identical objects, then the probability that such a chance judgment could have been rendered for the one particular word which had actually been changed among 8, is $\frac{1}{8} \times 17\% = 2.1\%$. This is assuming that the particular word in question is 100% S. But we cannot say that the same amount of error would enter into the judgments of change rendered for objects of less than 100% S. For such objects would possess a certain amount of dissimilarity which would have a tendency of its own to elicit the judgment "change." And in proportion as such objects were removed from 100% S, in that proportion would that inherent tendency increase, while the tendency to say "change" on the basis of illusion or mere chance would diminish. Moreover, it has been shown conclusively that it is much easier to recognize a new object as different than a previously experienced object as the same.[8]

Now we have said that there is a simple inverse relation between degree of similarity and recognition. Therefore, inasmuch as 17% of error was made with respect to 8 words of 100% S, the amount of error that would have been made with respect to words of 87% S is $0.87 \times 0.17 = 0.14$, i.e. 14%. But since only one word was changed among 8, the probability of

[8] Meumann, *op. cit.*

saying that that particular one was changed, whether the change was noticed or not, would be .78 x .17 x 1/8 = 1.7%. And so on down the scale, clear up to the point where the probability of declaring a word of 0% S changed, on the basis of mere chance, would be 0 x .17 x 1/8 = 0.

Hence, we may say in general, let X be the per cent of wrong judgments, i.e. judgments of change when no objective change occurred, and let S be any particular unit on the similarity scale, and finally, let A be the number of items changed and B the total number of items exposed. Then our formula for the chance correct judgments is

$$SX.\frac{A}{B} = K'$$

which value must be *subtracted* from % C corresponding to the %S in the formula.

On the other hand, when we turn to the zero end of the scale, we find that our observers failed to recognize 9% of the substitutions. Evidently the conditions of the experiment were such that that number of objects of 0% S or 100% D, (D = dissimilarity), escaped the attention of the subjects. Is it not likely, then, that the same thing happened with respect to the other units of the scale? Again we answer no. For we have no right to assume that 9% of the substitutions of 87% S also escaped recognition owing to the conditions of the experiment, because such words contained a certain amount of identity—87%—which would have a tendency of its own to elicit the judgment "the same." Likewise with words of every value of S.

Suppose we let 0% S = 100% D, 25 % S = 75% D, and in general x% S = (100-x)% D,[9] then inasmuch as the subjects failed to recognize 9% of the changes in a 100% D substitution, in a 75% D substitution they would fail to recognize .75 x .09 = 7% of the changes. And so in general, the number of substitutions that our observers would have recognized, if the conditions of the experiment had been ideal, would have been,

[9] This relation, as Hollingworth has shown, does not always hold for subjective judgments.

in addition to those already recorded, (100-S) x .09 for any value of S. This value must be *added* to % C in each case. If now we let Y stand for the per cent of the cases in which the observers failed to recognize the substitution of a totally dissimilar object, our Correction Formula becomes

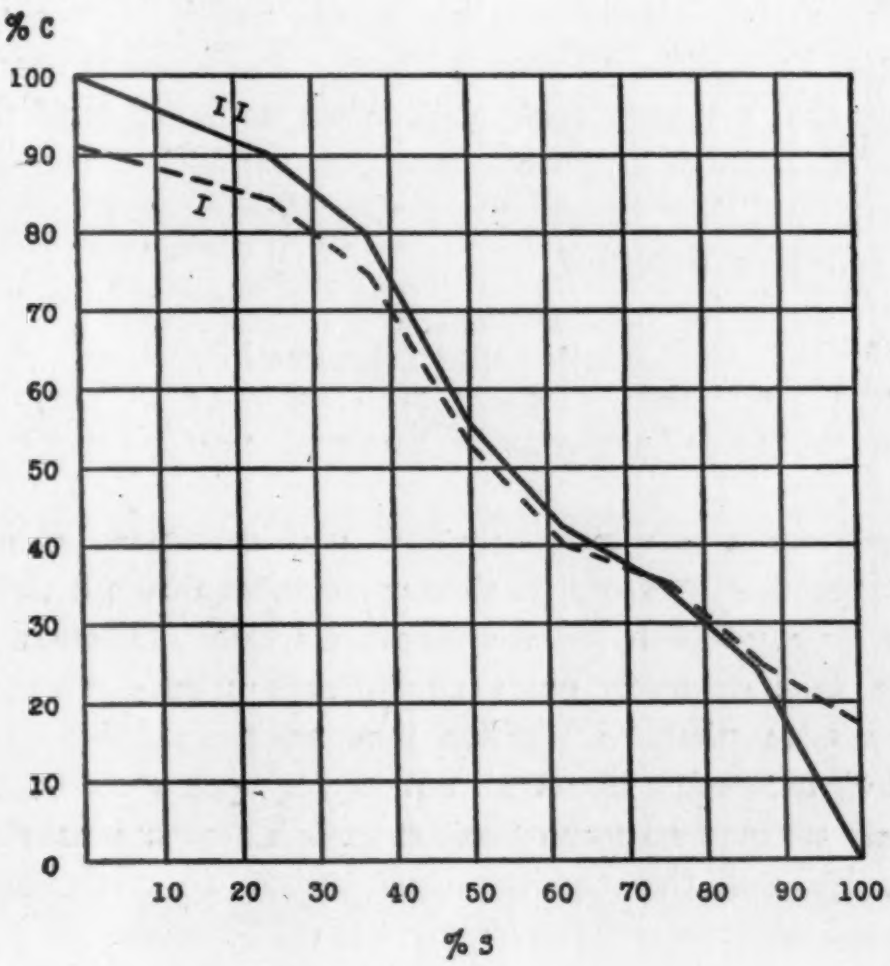
$$(100\text{-}S)Y - SX.\frac{A}{B} = K$$

which value, with its algebraic sign, should be added to % C corresponding to the S in the formula. If we apply this formula to the Av. % C's in Table 8, we obtain the "corrected results" which appear in the last horizontal line of that table.

By arranging our stimuli along the abcissa and the recognition judgments along the ordinate, we obtain the curves in Plate I. Curve I is drawn on the basis of the uncorrected judgments, curve II represents the results after the Correction

PLATE I

Per Cent Correct Recognition when Tri-syllabic Words are Exposed in Groups of 8 for 4 Seconds.



Formula has been applied, i.e. as they would have appeared if the conditions of the experiment had been ideal. In reading the curves it should be understood that % C means per cent judgments of *change,* which judgments were correct in all cases except where S had a value of 100%.

NOTE—The full advantage of the Correction Formula will become apparent in the last part of this paper—the part on applied psychology. Suffice it to say at this point that it serves to establish a relation between degree of similarity and recognitive ability in terms of the O-and 100% S ends of the scale, and in doing so it makes that relation practically absolute.

ANALYSIS OF RESULTS

How were the judgments distributed and why did some of them vary so largely with words of the same mathematical value and approximately of the same psychological value? For example, W(33) which equals 75% S yields 0% C, whereas W(40) also having a value of 75% S yields 100% C.

The first part of the question is answered by Table 9. If + = a correct judgment respecting a change or no change, according as one was or was not made; and if — = a wrong judgment, i.e. failure to note a change when one occurred or asserting that a change took place when none did; and finally, if ± = a doubtful judgment—one that varied between 20 and 79% certainty, then we see that the judgments were distributed in the following manner:

TABLE 9
Distribution of Judgments

% S =	0	25	37	50	62	75	87	100
+ =	19	12	11	7	6	6	3	14
± =	4	6	7	6	4	2	4	5
— =	—	—	1	6	10	12	13	1

Table 9 shows very strikingly how, with increasing similarity, the judgments pass from positive correctness through doubt to definite error. When the stimuli were totally dissimilar, none of them were definitely mistaken for each other. About 17% of them were doubtful. When they reached 25% S, 33 per cent of them became doubtful, but as yet none were mistaken. It is only when the stimuli become 37% S that a positive mistake occurs, and this happens once out of 19 trials, but the number of doubtful judgments rises to 37%, while the correct

ones diminish correspondingly. When the stimuli are 50% S, the judgments are distributed almost equally over all possibilities: 36% are correct, 32% are doubtful, and 32% wrong. Theory would call for 33% in each of the cases. That our distribution should come so close to the requirements of probability, argues most forcibly for the integrity of the similarity scale as a whole, as well as for the method employed in its construction.

As the similarity still increases the quality of the judgments continues to change in a definite way—the correct ones diminish, the incorrect ones increase, while the doubtful ones also decline because there is not so much possibility now for vacillation. Either the substitution is noticed or it deceives the observer completely. This relation occurs with increasing emphasis in the 75% S and 87% S units. Finally, when we come to the case where the second stimulus is identical with the first—100% S—we have a return to the conditions that obtained when the stimuli were totally dissimilar.

In trying to answer the second part of our question: Why do the recognitive judgments vary so widely with respect to words of approximately the same value? we are brought face to face with the burden of our thesis. But we have to analyse many factors that enter into the process of recognition before we can answer that question. Believing with Wundt that mental response is a function of two independent variables—the external stimulus, on the one hand, and the internal resistance, on the other—we are going to examine some introspective data with reference to the words that elicited them.

We have already stated that the recognitive process which we are examining, especially with the word material, is slightly tinged with immediate memory. That is to say, in some cases the observer was able to retain during the interval several words from the first exposure. Yet these memorized words played but a small rôle in the process of recognition. For in the first place, the average number of words carried in memory varied from 3 to 5, so that there was an equal chance that the observer did not carry the critical word. Secondly, introspection shows

that though the words carried in memory are identified with more certainty, yet any one of these memorized words can be easily replaced in consciousness by a perceived word which closely resembles it, i.e. the perception is frequently stronger than the memory. Finally, the fact that some of the words were retained in memory, only served to reinstate the recognitive process as it functions in daily life. For it is not only things which loom up suddenly and unexpectedly that awake the process of recognition. On the contrary, in the majority of cases we have to recognize persons, things and places of which we already have a more or less clear idea as to how they appear.

Our experiments enable us to analyse three mental factors: (1) The recognition of totally different things. (2) The errors that arise from the attempt to discriminate similar things. (3) The recognition of identical objects. The data for the examination of this last factor must be gathered from those cases where only one word was repeated in a new environment. Here we shall obtain a contrast between the feeling of familiarity produced by the repeated word and the feeling of strangeness aroused by the new setting,

Suppose we start with the first factor mentioned. One of the primary things that strikes our attention when a totally dissimilar word or object is substituted for another within the same milieu, is that in a large number of cases the perception of the second item knocks the idea or memory image of the first out of mind. But although the standard is lost from consciousness, the variable is none the less recognized as new with great positiveness and accuracy. Thus introspection reads:[10]

2:0%S

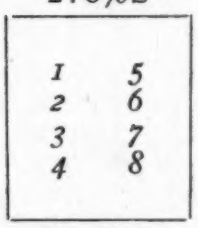


FIG. IV

8 A = cullender, 8 B = society.

Ha. + (?): "Society" is new, 80 per cent sure. I knew what 8 A was, but the impression of 8 B knocked the other one out of my mind.

Bu. + (−): I am sure 8 B is new. I do not remember what was there before.

[10] The rectangular figures represent the printed cards, the numbers within indicate the order of the words; the numbered letters appearing in intro-

The formation of associations, however, may be helpful in the retention of the original impression.

17:0% S. 6 A = Elliott, 6 B = Manual.

Ha. + (+): 6 B is new, 100% sure. I had associations with 6 A; it became strongly impressed. I had images of 5, 6, 7, 8; these and the others, except 6 B, look familiar.

Ke. + (—): "Manual" seems strange, 80% certain that it is different. I don't know what was there before. Sometimes it seems to me as if I had an image of the other word, but I cannot say what it was. I carried 1, 5, 7, 8 during the interval in mental imagery.

Sometimes the physiological processes set up by a totally dissimilar stimulus are so different from those experienced immediately before, that the substitution will be recognized in terms of the new psychophysical states it arouses.

39:0% S. 4 A = endoderm, 4 B = typebar.

Ha. + (—): 4 B is new, 100% sure because it felt new in visual, kinaesthetic and associative terms. It is a word that calls up associations promptly. I don't know what word it displaces.

Bu. + (—): 4 B is new, 100% sure. The others are familiar. The pronouncing of 4 B in inner speech produces a sort of shock due to its unusual rythm, i.e. it does not have the same number of syllables as the other words. If it had been present in the first exposure, this rhythmical peculiarity would have attracted my attention.

Ke. + (—): 4 B is new, 100% certain. I knew what was in its place before, having carried 1, 4, 7, 8 in memory, but I cannot recall it now. The sound of 4 B requires more tension in the vocal muscles than the others, therefore it stands out from them as strange.

Frequently the totally dissimilar word manifests itself by the disturbance it introduces into the psychic processes aroused.—Thus:

45:0% S, 6 A = roadside, 6 B = germinal, one observer de-

spection are used for abbreviation. Sign in () indicates whether displaced word was remembered.

clares, Ke. + (—): 6 B is new, 100% sure. I do not remember what was there before. I had images of 1, 3, 5, 7 and 8. 6 B does not seem to fit in with anything in my consciousness as the other words do. On seeing the first, vague associations were formed, but now this word—6 B seems to break those associations up. Moreover, it has a verbal and meaningful strangeness of its own.

According to this same observer, the newness of a totally dissimilar word consists in that it does not seem to take up any of the mental processes started by the first list as the other words in the second list do. Instead of that it sets up a new mental process peculiar to itself.

The exposure time—4 seconds—was just long enough to enable the subjects to go over the list of 8 words once or one and a half times. It happened only on two or three occasions out of 150 exposures that a subject failed to read all the words before the shutter went down. The shortness of the exposure prevented the memorization of the words, but it did not prevent their apperception. It is true that in some instances the words did not have rich meaning, i.e. the real concepts they stood for did not always rise to the center of consciousness; but the observer always got enough meaning from the words to know that they were intelligible. They aroused a definite state of consciousness and produced a fixed attitude. The short exposure simply prevented them from being completely developed in mental imagery and from being interlocked by associations.

Methods of Recognition

There are three possible ways of recognizing an object under the conditions of our experiment. (1) Imagery of the objects seen is carried throughout the interval between the first and second exposure. These memory images are carried either in visual, verbal or auditory terms. In the mixed mental types the terms will vary with the nature of the material. (2) The memory images may vanish during the interval and be revived by the re-perception of the original object or merely by the perception of the position originally occupied by the missing object.

In this case the revival of imagery helps to strengthen recognition or makes the recognition of a new item more certain. (3) The recognitive consciousness may be a matter of feeling, or of kinaesthetic attitude or of adjustment, or of the revival of a mood. The perceptiοn, or, in this case, the meaning of the word fits right in with the existing attitude. It is not necessary to pause to get the meaning of the recognized word, but, as one of the observers remarked, "it fits right into consciousness as a plug fits into its socket."

The ability to recognize an object in a totally dissimilar setting from the one in which it was originally seen, proves conclusively that recogniton is independent of conscious association. Nevertheless, the fact that a totally dissimilar stimulus can obliterate its predecessor, as we have already shown, whereas a somewhat similar stimulus can revive its predecessor, as we shall presently show, indicates that some kind of association—perhaps a subconscious association may occur in some cases of recognition.

The fundamental factor of the process of recognition is the feeling of familiarity. But how is that feeling related to its opposite—the feeling of strangeness? Do these two feelings neutralize each other by fusion or do they intensify each other by contrast? I had ready means at hand for finding that out. Hitherto I had made substitutions in the same surroundings in which the standards had been seen, and obtained certain values with each degree of similarity. Now what would happen if the same substitutions were made in a totally different environment, i.e. instead of exposing the variable word in the same field in which the standard had appeared, what if it were exposed in a different one? Would the observer be able to recognize the imitation or the identity, as the case may be, in this second instance as easily as in the first? If not, then it would mean that the feeling of strangeness aroused by the new setting tends to inhibit the feeling of familiarity, or better still, tends to swamp it by suffusing itself over the whole of consciousness. If, on the other hand, recognition would improve in this second case, then it would show that the feelings

of strangeness and familiarity enhance each other by contrast, as complementary colors do.

Experiments with both kinds of material—words and picture post cards, substantiated the former proposition, namely, that the feelings tend to fuse, that one of them gaining the upper hand in consciousness which is fed by the larger number of stimuli. If we glance at Table 8 we shall see how the figures bear out this statement. When all 8 words were repeated the second time the subjects recognized them as identical in 83% of the cases. In other words, there were 17% of errors. But when *one* identical word was repeated among 7 new ones the errors rose to 27%. Even if we apply our correction formula, in order to subtract the number of judgments "change" which were made as a result of the precipitant tendency to say change, the error still remains 25%. We are justified in saying, therefore, that if, under the conditions of our experiment, a stimulus A, originally given in a setting BCD, is subsequently repeated in a totally different setting EFG, the odds that it will not be recognized are 1 : 3, or the chance of its recognition is 75/100; whereas if it is repeated in the same setting the chance of its recognition is 98/100.[11]

Let us now see how introspection supports our data.

19: 100%S[12] in N.E.

1	5
2	6
3	7
4	8

FIG. V

2 = dandyish

Ha: — : All changed; 100% sure that all but "dandyish" are changed, and 90% certain that it also is new. When the shutter went up the second time I found none of the words that I had carried over from the first exposure. And as I kept looking at the words I saw that they were all strange. I had a feeling that this second list was a new assortment. The words suggested new ideas. *And this feeling of strangeness increased in momentum as I went on reading the words.*

Bu: ± : 2 seems familiar. I had no image of it, but it struck me as familiar.

[11] The theory of this has been discussed on page 36.

[12] 100 % in N.E. = one identical word in a new environment. See Fig. III, p. 34.

Ma: — : All seem strange. I got a general impression of strangeness.

30: 100%S in N.E.

1	*5*
2	*6*
3	*7*
4	*8*

FIG. VI

4 = heritage.

Ha: + : Heritage is the same, 100% sure. The others are new. As soon as I saw that more than one were strange, I began to look for a familiar word. And I got a decided feeling of familiarity when I came to 4, but when I began to think about it the feeling diminished.

This last statement is important in its bearing on the process of recognition. It is common knowledge that the recognitive process takes time to develop. I found that in my experiments, as we shall have occasion to see. Moore also found it in his investigation on abstraction.[13] But now when we get the complement of this and note that the process of recognition also atrophies with time, we have double proof that recognition is an affective process, since feelings alone take time to develop. There were several occasions on which my observers declared that a word looked more familiar the instant they saw it than it did a few seconds later.

It should not be supposed that the task of discovering an old item in a new environment is more difficult than that of discovering a new object in the old setting, because it takes more time to apperceive new objects than those already experienced. That is not so. On the contrary, when the surrounding words in the second exposure are new, the subjects run over them much faster than over the same list repeated. The reason is that it takes less time to see that a thing isn't than that it is. We should be in a sad plight if it took us as much time to discriminate as it does to recognize. I go into a store to purchase a tie; with one sweep of the eyes I eliminate the colors and patterns that I do not want. Of course, I don't know their texture nor any of their virtues. But that does not matter. I know all I care to know about them—they are not what I want. This life fact is substantiated in our experiments. Referring to group 30 subject Ke. says:

[13] The Process of Abstraction, T. V. Moore, Univ. of Calif. Pubs., in Psy. Vol. I, No. 2, p. 161.

"Heritage is the same; 100% certain. I had a lot of images during the interval. It was easy to solve this problem. On seeing the second card I discovered one word (4) of which I had an image during the interval. I looked for others, but finding none, I kept rushing over the list. *I did not stop to get the meaning of the words. I could see at a glance that they were not familiar ones. So I hastily dismissed them.* But when some or all the words are repeated, I have to read them carefully in order to see whether they are all the same or not. It is easier to distinguish what you do not want than to pick out what you do want." [14]

Eliminating, therefore, the only objection that could possibly be raised, we must conclude that the reason why it is so difficult to recognize an identical item in a new environment, is that the feeling of strangeness produced by the new setting, suffuses itself over the whole of consciousness and blots out the opposite feeling—that of familiarity, according to the principle of what in chemistry is called "mass reaction." The following case proves this.

38: 100%S
in N.E.

1	5
2	6
3	7
4	8

FIG. VII

7 = strategy.

Bu: —: All different, 90% certain. I had images of 3, 5, 6, 7, 8. When the shutter went up the second time I began to read column 2 downward rapidly and saw that each of the words was new. The feeling of strangeness kept growing on me and developing the judgment, "All different." I was on the look-out for a repeated word in column I, but found none. (At this point I told the subject that "strategy" was the same, and I asked him why he failed to identify it. He replied), The reason why I did not recognize "strategy" is because I read too rapidly, I think. Probably, too, by the time I had read the first two words the feeling of strangeness had spread itself over "strategy" giving it also the coloring of newness.

[14] Meumann, in the article already referred to, finds practically the same thing.

Errors of Recognition

Error of recognition or inability to recognize, may be due to any one or to a combination of the following factors: (1) Lack of memory. (2) Incomplete perception of the standard stimulus when first presented. (3) Incomplete perception of the variable stimulus, mistaking it for N, the normal. This, I postulate, is due to the superiority of the ideo-motor force over the sensory-motor force. (4) Obliteration from memory of the original N impression by the perception of the V stimulus—due to the superiority of the sensory-motor force over the ideo-motor force. (5) The collision of the I. M. and S. M. forces with equal momenta resulting in a doubtful judgment. (6) The induction by the represented stimulus of a new association or a new mood by virtue of which said stimulus appears novel or strange. (7) The inability of the original stimulus to revive an association or an attitude induced by it when first presented.

Let us consider these factors in their order.

(1) Inability to recognize owing to lack of memory manifested itself in those cases where the whole of the second exposure was identical with the first. The subject would doubt a word among the 8 identical ones because he could not recall having seen it before. Thus, for groups 48 subject Ke. says, "I could not remember "oration" on seeing it the second time, therefore, I think it is new; 75% certain. I carried 5, 7 and 8, and I recognized these and the others, but not "oration". It does not look strange, but I simply cannot recall it."

What subject Ke. means, of course, is that the perception of the word "oration" did not revive the memory idea of having been seen before. This does not say, however, that recognition depends on memory altogether. It simply means that where the repeated stimulus fails to revive its particular mood, or where it fails to make a sufficiently deep impression on consciousness on its first presentation, it has to awake a pure memory idea if it is to be recognized at all. This memory idea is frequently colorless. The subject would often say that he

remembered the item in the same way that one remembers a fact or a date.

(2) Where it was a case of incompletely perceiving the object when first presented, the observer would either fill in the missing details or else he would suspend judgment on the second presentation of that item, and declare that he recognizes only so much of it as he had originally seen, but cannot say anything about the rest of it. These cases were more frequent with the picture post cards than with the words. The following case is characteristic.

Group 33: Subject Ke: —: No change. But I am puzzled. I did not have time to read the 6th word, "occupant". All I saw was that it began with "o" and ended with "nt;" so I thought during the interval that the word was "occident". But now I see that it is "occupant." I do not know what to say. I am sure the others are the same, and I think "occupant" was there before also.

(3) It will be remembered that the second exposure was the same length as the first—4 seconds. The reason for this is that even in the very act of recognition it was desired to duplicate the very conditions of life. Not only do we generally perceive things hurriedly, but in the rush and tear of life we have to pass judgment upon them more or less rapidly and under trying circumstances. Afterwards we may think about our reaction to the critical situation—be that reaction in the form of a discussion or an opinion or a purchase—as much as we please; but in actual life it is never given us to live through the same critical moment twice. Likewise in our experiment. The individual had to get the decisive impression from the object or its substitute in a limited time. He could, after the shutter went down, take all the time he desired to render his judgment. But that judgment would have to be based on an impression that was limited in duration, that occurred when attention was distributed, when there was a conflict between several motives, and when consciousness was flooded by a multitude of ideas.

The shortness of the exposure, then, permitted the study of this very important cause of false recognition, namely, the in-

complete perception of the substituted item. It should be understood, however, that this is not the entire cause. On the contrary, it is only a contributive cause, the main one being the "push" that is given to the perceptual process by the ideo-motor force which had been induced by the standard stimulus. Hence, it follows that this kind of error can occur only where there is considerable objective similarity between the N and V stimuli. There was not a single instance of its occurrence with stimuli below 50% similarity.

How are the errors resulting from the incomplete perception of the variable stimulus caused? I show a person a list of 8 words, among which is a given word whose structure is ABCD. After a short interval I re-expose the same list with the given word replaced by another of slightly different structure—say ABCX. And the observer reads the second list, and says, "Yes, I find all the words there, including ABCD." Now this is not a case of merely false perception. It is not simply a matter of mistaking an X for a D. But it seems that the brain process set up by the first word, absorbs the second word owing to the common elements ABC. The extent to which this will happen is directly proportionate to the ratio of the common elements, ABC, to the variable elements, D and X. Before a man can see a bear in a bush he must have a strong idea of the bear, on the one hand; and the bush must have some resemblance to the bear, on the other. So with my subjects. They had a clear and distinct idea of what the original word was, and now they sense an item that begins to follow the same cerebral path pursued by the original stimulus. Before they are aware of it, however, this second impression is drawn off completely into the brain path developed by the standard stimulus. The occurrence of this event, therefore, depends on two factors; first, the ratio of the common elements, ABC, to the variable elements, D and X; and secondly, it depends on the strength of the original idea or the ideo-motor force. That this error is not due to the shortness of the exposure, but is rather a function of the % S and I. M. F., is manifested by the fact that it occurred only among

those stimuli that were over 50 per cent similar, with a frequency directly proportionate to increasing similarity.

Let us cite a few cases.

22:87%S

1	5
2	6
3	7
4	8

FIG. VIII

3 A = sanctify.
3 B = sanctity.
Ha. —: No change, 100% certain. Visual and auditory images of 2, 5 and 3 A, but others fitted in so smoothly that I feel sure of them. I formed an association between 2 (yeomanry) and 3 A. Such an association tends to make the constituents persist longer in memory during the interval. I found 2, 5 and 3 A on the second exposure.

Ma. —: All seem the same; 100% sure. The impression of familiarity that I received from those that I am positive of, seems to spread itself over the rest of the words.[15] The ones I am sure of are 3 A, (sanctify), 4, 5, 6, 7. I think I looked at the whole of 3 A on the second exposure. (When told that it was 3 B (sanctity) and not 3 A, he said), Well, when I saw the second exposure I read the word as "sanctify" and it sounded familiar; so I took it for granted that it was a repetition of the word I had seen there before.

20:75%S

1	5
2	6
3	7
4	8

FIG. IX

5 A = rebuttal.
5 B = rebutter.
Bu. — : No change; 80% sure. I had images of 4, 5 A, 6, 7, 8, and I found all these on the second exposure. When the shutter went up the second time I looked at column 2 and found that all the words there were the same. That gave me a feeling of satisfaction. Then I went to column 1, and though I got a neutral feeling from the words within it, I nevertheless judged them to be the same. I went over the list once on the second exposure and saw each word distinctly.

Thus we see how the subject carrying in his mind the idea "sanctify" or "rebuttal" finds these ideas in the structurally similar words "sanctity" and "rebutter."

[15] It is interesting to note in connection with this that Katzaroff (La Recognition, p. 57), also found that "the feeling of certainty is more or less contagious."

Of course, such phenomenon is a common occurrence, especially among authors who try to correct their own manuscript. Despite repeated readings, they continue to omit words or to overlook misspelling simply because they are so imbued with the subject-matter that they supply the missing items mentally, thus failing to supply them materially. And the more knowledge they have of their subject, the more errors in writing will they overlook. Likewise with my observers. If they had a clear memory of the standard word they did not pause to get a distinct perception of the variable. On the contrary, in such a case the bare perception of the initial syllable or two would so reinforce the memory idea of the original word as to make them think that this clearness had an external source, i.e. that the standard word was there before them. For reasons that I shall presently make clear, I call these kinds of errors errors of "is", meaning thereby that the variable *is* the normal; and I postulate that indirectly they are due to the degree of similarity between N and V and directly to the superiority of the ideo-motor force over the sensory-motor force.

(4) But this is not the greatest source of false recognition. On the contrary, errors of this kind are relatively small as compared with the errors that result from the superiority of the sensory-motor force over the ideo-motor force. An impression ABCD is given to a person and shortly afterwards another one ABCX, but instead of declaring that he still perceives ABCD, as in the previous case, he now asserts that ABCX is what he had experienced the first time also. These kinds of errors we shall call errors of *"was"*. How is this phenomenon to be explained? It is not merely the obliteration from memory of the first impression by the second. For while such obliteration can and does take place, it does not follow that the second perception will be taken for the first, or that perception B will be taken for perception A simply because it has expelled the latter from memory. Let us cite a few instances.

Obliteration is a very common occurrence when the N and V stimuli are o% S. The V comes along in the form of a perception and drives the memory image, or the pure idea of N so

completely out of mind that the observer has not the faintest recollection of what was there before, yet never will this variable be mistaken for the normal. It produces a mental process all its own, and thereby suffuses itself over consciousness so thoroughly that the other contents vanish sometimes temporarily, sometimes permanently. (See introspection for group 45, page 43.) But it is always recognized as new by virtue of its uniqueness. Not infrequently the subject would say that the 0% V struck him like a flash of light thrown into the eyes, and just as such a flash wipes everything out of sight, so does this V wipe out all knowledge of what was in its place. But it forces its newness on consciousness with an irresistible force.

Where similarity was almost zero, say 25% S, obliteration would also occur without diminution of recognition. That is, the difference between the V and N was still large enough for the former to produce a conscious shock of its own and at the same time to destroy the reverberations of the latter. The following instance is characteristic:

Group 37: 37% S: 7 A = politics, 7 B = polander.

Ke. + (—) 7 B is new; 100% sure. I cannot say what was there before. 7 B stands out both in meaning and imagery from all the other words. All the rest are familiar. I read the second list in the same order as the first. When I came to 7 B there was a sort of break or check; I had to stop to get both its meaning and sound. It is a feeling like that which one experiences when one is running down a hill at full speed and suddenly comes up against a fence. He is upset, but he knows what upset him.

The errors we are now considering are, therefore, not due to the obliteration alone, i.e. they are not the result of the relation between the S. M and I. M. forces alone, but they also depend upon the degree of similarity between the N and V stimuli. This is demonstrated by the fact that they rise in frequency with every increase in similarity. The following table bears this out.

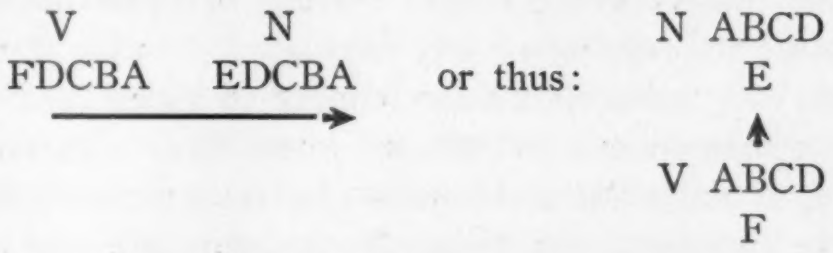
TABLE 10

Distribution of Definite Errors[1]

%S =	0	25	37	50	62	75	87
Errors of *is* (V read as N) =				1	1	1	2
Errors of *was* (V said to have been N) =			1	5	9	11	11

[1] See also Table 9.

I trust no one will accuse me here of trying to maintain that we read words letter by letter. That this is not so has been sufficiently demonstrated by Cattell [16] and others. But we do perceive words after they have set up certain cerebral processes. The exact nature of these processes is not our immediate concern; neither does it matter whether they are to be measured lengthwise or breadthwise. That is, we may conceive the V impression running along the single brain track produced by N in the following manner:



In either case this kind of false recognition involves three factors: (1) The V impression must run along part of the path of the N impression; (2) it must set up a brain process of its own in order to be perceived; and (3) it must destroy the cerebral reverberations of N in order to drive it out of memory. The first of these three factors depends on per cent S; the last depends on the relative strengths of the sensory- and ideo-motor forces. Table 11 shows that this ratio is about 7 : 1.

How do we know that all these three factors contribute to false recognition? May it not be, for instance, that the impression of V does not actively obliterate the memory of N? May it not be that the observer has forgotten during the interval what N was, so that he has not the faintest idea of it even before the shutter goes up for the trial exposure? Moreover, according to the law of association by similarity, the more similar V is to N, the more likelihood should there be that the perception of V will revive the idea of N instead of blotting it out.

We have already shown, however, that obliteration actually does occur when the similarity between V and N is 0%.[17] It is now incumbent upon us to prove that it also takes place when

[16] The Time it Takes to See and Name Things, *Mind*, Vol. X (1886).
[17] See pp. 53-4.

the similarity is high. This proof is furnished by the following facts:

(5) With every degree of similarity there were cases when the observer was confronted by both the memory of N and the sense impression of V. Thereupon a doubt arose in his mind as to whether the substituted word was the one he had seen on the first exposure or whether the memory idea carried over from the first exposure was a delusion. And in proportion as the similarity increased the observers dismissed their memory ideas, which were correct in all instances, and decided in favor of the immediate sense impression.

The following table shows the number of times conflicts between the memory ideas and sensory impressions occurred with each degree of similarity, and how the decisions were distributed. It should be understood that by conflict I mean the actual balancing of memory against perception. Naturally, these figures represent only those cases in which the V did not produce a clear shock of strangeness, and so needed the memory of N in order to be discriminated.

TABLE II

Final Decisions Resulting from Conflicts between Memory and Perception, i.e. between I.M.F. and S.M.F.

% S =	0	25	37	50	62	75	87
+ =	1	1	1		2		
± =		1	1		2		1
— =					3	1	2

We see how, with increasing similarity, it was the impression that won out and the memory that lost. Does not this indicate the superiority of the S.M. F. over the I. M. F.?

A few samples of introspection will show how the battle between these two forces was waged.

Group 17: 0% S. N = Elliott, V = manual.

Subject Ke. + (—): Manual seems strange, 80% sure that it is different. It seems as if I had an image of what was there before, but I cannot pronounce the word. I feel as if it were on the tip of my tongue.

Group 22: 87% S. 3 A = sanctify, 3 B= sanctity.

Subject Ke. I am not sure whether I saw 3 A or 3 B this

second time. It seems as if on the first exposure I had seen 3 A and now I see 3 B, but I do not know whether I saw it clearly or not this second time. It may be my memory is incorrect. The only doubt is about one letter. The first part of the word "sanct-" is perfectly familiar. As soon as the shutter went up the second time I read the whole list rapidly, and found them all familiar. Then I went back to 3 and hesitated. Even now, as I talk to you, there is a conflict in my mind between 3 A and 3 B, and I don't know what to say.

Group 20: 75% S. 5 A = rebuttal, 5 B = rebutter.

Subject Ha.—: I thought you had "rebuttal" there before, but now I see "rebutter". It may be that I did not see the last part of "rebutt-" in the first exposure and that during the interval I simply switched over to the more familiar word of the two, for 5 A is more commonly used than 5 B. I will therefore say no change, 80% sure.

Group 46: 87% S. 5 A = passible, 5 B = passibly.

Ke. — : I don't think there is any change, 90% certain. I carried 6 and 5, i.e. I carried number 5 in memory as "passible". But when I saw "passibly" on the second exposure, I took it for granted that that was the word I had seen the first time, and that I had attached a wrong end to it either while reading or thinking about it, i.e. I had put "ble" where "bly" was. That is the only way I can explain it. I'll say no change.

Group 28: 62% S. 7 A = manifold, 7 B = manifest.

Ha. + (?) : 7 B gives me a feeling of strangeness; 100% certain that it is new. I must confess though that the moment I began to think about 7 B the idea occurred to me that I had seen it in that position before, so I was going to say no change. But the first psychological impression I got from it was one of decided strangeness. This feeling of strangeness, however, began to diminish as I continued to think about the word. The more I think of it even now, the more does it seem familiar. I had visual and auditory images of 1, 2, 4, and "manifold". I do not know where I got the word "manifold", neither do I know why it kept running through my mind during the interval. It now occurs to me that the persistency of "manifold" during the

interval accounts for the fringe of familiarity that attaches to "manifest". I say this because somehow the two words are entangled in my mind. As I compare them I see, of course, that they overlap in some letters. The confusion may be due to that.

Bu. — : I carried "manifold" instead of "manifest" during the interval, yet "manifest" seems familiar. I do not know how to account for this phenomenon. I think the confusion is due to my own carelessness; I probably did not pay enough attention to word 7 when it first appeared. Or perhaps I just read the first part of it—"mani"—and tacked on the last part—"fold". It is also probable that I simply read "manifold" instead of "manifest". Whatever the cause may be, I am certain that I carried "manifold" in my mind during the interval. But since "manifest" looks familiar I'll say no change. I had images of 1, 2, 5, 6 and 7 A.

Group 24: 62% S. N = tyrannous, V = tyrannize.

Ha. — : None changed, certain. I had little imagery during the interval. But they all look familiar, though I confess that I really expected to see "tyrannous" where "tyrannize" is now. I cannot say why I had this expectation. Perhaps a vague image of "tyrannous" had crept into my mind during the interval and persisted there. (Here I asked the observer, If you had found tyrannous where tyrannize is now, would you have accepted it as familiar?) "Oh, there is no doubt, for it would have fitted in with my expectation", was the reply.

It was enough for the new word to blot out the non-common element of the old word and to intensify the common part, thereby making itself acceptable in consciousness while it revived, or better still, allowed only a partial echo of the previous one to resound. In some instances this partial echo, like the ghost of Hamlet's father, had the strength to cry out against the intruder; in others it was "very faint." Note the following case:

Group 36: 62% S. 4 A = fabulous, 4 B = fabulize.

Ke. + (?): "Fabulize" seems new, 100% certain. The effort of inner speech in trying to pronounce it is very marked, especially with the last part of the word- "ize"-. It is a sound

that involves more mouth movement. The first part of the word seems familiar in visual terms. During the interval it seems that I thought of the word "fabulous." That is the word that must have been there before, but I am not sure, for it may also have come into my mind by association on seeing "fabulize".

Ma. ± (?): "Fabulize" seems new. I'll give it 60% as being new on the basis of sound. This word differs from the previous one in the z sound.

No further proof seems to be necessary to show the triple way in which the substituted word functions in having itself accepted for the genuine one. Even where it fails to obliterate the memory of the previous word entirely, it tends to do so with increasing force as it approaches the normal word in degree of resemblance. This is indicated by the figures in Table 11. As the similarity increases the subjects tend more and more to say to themselves that the echo of the N word is a delusion, or that it is too faint to rely upon, and so they accept the variable for the normal with increasing assurance, thus committing more definite errors. Here we have concomitant variation. It is only logical to conclude, therefore, that all the errors of "was", (where V was said to have been N), result from the superiority of the sensory-motor over the ideo-motor force.

(6) It happened occasionally that a subject would mistake one of the words constituting the milieu as being new because it produced an association or an attitude not experienced on the first exposure. Thus in group 35 "oiliness" was one of the 7 words making up the setting. When this group was exposed the second time, observer Bu. said, "I am doubtful about "oiliness" because if it had been present before, I should have had tactual imagery with it such as I get on seeing it now." The same subject declared he was positive that he saw all the words on the first exposure.

(7) It is difficult to draw a sharp line between the cases that come under (6) and those where the repeated stimulus was mistaken for new because of its failure to revive an image

or an association previously experienced. I have only one such instance that bears sharp lines of distinction.

Group 41: 100% S. Ha. — : "Polemic" is new; 100% sure. It does not fit in with the association of the first exposure. It is unusual. But as I think about it, I feel less sure that it is new.

NOTE.—Because form is the most conspicuous feature in the visual realm which causes confusion we have taken that as the basis of differentiation in the construction of our similarity scale. Our method has been justified both by the psychological judgments and by the results of the recognition tests. But now, what should be done with those few words which, possessing the same structural similarity yielded such large divergent results in the tests on recognition? (See Table 8, W. 33 and 40.) Our answer is that such words, whenever they occur, should be treated like other exceptional phenomena in nature—the cause of their apparently exceptional character should be sought for.

The similarity of words No. 40 was 75 per cent, yet the substitution of one for the other was recognized 100 per cent of the times. An examination of the protocol shows the reason why. The non-common elements in these words are so diverse that they sufficed to counterbalance the elements that are common. Thus introspection reads: 40:75%S. 2A = parallel, 2B = parallax.

Ha. + (—): 2B is new; 100 per cent sure. I do not know what was there before. It felt new the instant I saw it. It did not fit in with any of the associations I had received from the first exposure, and it awakened a lot of new associations. It has an unusual combination of sounds; *the end especially sounds very queer.* All the others are familiar.

Bu. + (—): 2B is new; absolutely certain. That 'x' at the end of 'parallax' is altogether strange in sound. The first part of 2B reminded me of 2A.

Ma + (+): 2B struck me as quite strange, and at the same time I got a verbal image of 2A. 100 per cent certain 2B is new. All words seemed familiar until I came to 'parallax,' when the 'ax' struck me as strange. It did not seem to sound just right.

CONCLUSIONS

The results of our experiments up to this point seem to justify the following conclusions:

(1) Among words there are two kinds of similarity—internal or meaningful similarity and external or structural similarity—both of which are capable of producing confusion in the recognitive consciousness.

(2) Internal similarity has no fine gradations, the highest attainable degree being that which would fall about midway on the scale of structural similarity.

(3) There is a simple inverse relation between degree of similarity and recognitive ability, the one being to the other, in terms of percentage, as X: (100-X).

(4) It is more difficult to recognize the same thing in a totally new environment than in the same environment—the ratio of difficulty being approximately as 12: 1.

(5) It is more difficult to recognize the same thing in a totally new setting than a totally different object in the same setting—the ratio of difficulty being 3: 1. It is understood, of course, that the variable and normal items must belong to the same category of objects.

(6) The feelings of familiarity and strangeness tend to neutralize each other by fusion, that one gaining the upper hand in consciousness which is induced by the more intense stimulus.

(7) With high similarity the majority of errors are due to the obliteration from memory of the original N impression by the perception of the V stimulus, owing to the superiority of the sensory-motor force over the ideo-motor force.

(8) Doubt arises from a conflict of these two factors—the perception or the memory triumphing according as objective similarity is high or low.

PART III

Experiments with Picture Post-Cards

The question now arises, to what extent are the foregoing results true for recognition in general? In order to verify them we looked about for material that would be less artificial than words and more representative of real life situations. Still applying ourselves to the visual realm where, as Katzaroff says, the largest part of life's experience is cast, it occurred to us that picture post-cards would be the ideal material; since they represent all kinds of scenes and situations—such as streets, parks, buildings, landscapes, sea-scapes, plants, animals, and men, women and children in different activities and groupings;[1] in short, everything that anybody can conceive of perceiving in daily life and be called upon to recognize later on.

In order to grade these cards we resorted to the judgments of 15 mature and competent men. It has already been shown in the word series that such judgments of similarity are fairly reliable, and, in the main, quite representative of the objective similarity determined by a mechanical process. These psychological judgments, moreover, were found to harmonize not only with the mathematical values of the words, but also with the recognition values obtained from different individuals. This, it seems, is sufficient proof of the reliability of a large number of judgments, rendered by competent individuals, concerning objective similarity.

We, therefore, proceeded to grade these picture post-cards in the following manner: Two cards that were totally dissimilar—one representing a large red rose and the other a gray church building outlined against a blue sky—were put side by side and given the arbitrary value of zero similarity, (0% S). Two other cards that were identical were placed beside the first pair and labeled 100 per cent similar, (100% S). These two pairs of

[1] This material is now filed at the Harvard Psychological Laboratory.

cards were hung upon a wire rack. Beneath them, in three or four horizontal rows, were strung up the 25 or 50 pairs that were to be judged. The backs of these cards were marked 1 A, 1 B; 2 A, 2 B; . . . . nA, nB. The A card was placed to the left, the B to the right in the standardization process, and the former used as the standard the latter as the variable in the recognition tests. Fifteen individuals were then called into the experimenting room, one at a time, and given the following instructions: "You have before you a number of picture post-cards which come in pairs horizontally arranged. I want you to look at them and to tell me how similar you think the members of each pair are to one another, expressing your judgment in terms of per cent. Let the upper two pairs of cards serve as the opposite ends of the scale, i.e. as the zero and identity ends, and between these two extremes you will try to locate the rest in terms of 10 or miultiples of 10. You may look over all the cards before you begin to judge, but give your judgment on the basis of the first impression in each instance."[2]

These 15 judgments rendered, I calculated their average and called that the objective similarity of the corresponding pair of cards. Each pair was then placed into an envelope which was labeled with the number and value of its contents and filed for use. The reliability of this arithmetic average was, of course, determined by the mean variation. The mean variation differed with every degree of similarity owing to the fact that it was a function of the range of judgment, as it should be. That is to say, cards that were rated at 45% S had a larger M. V. than those that fell within the 0% or 80% unit of the similarity scale. The reason is that cards of 45% S afforded a wider range of judgment—a range that theoretically varied between the 0 and 90% units of the scale—than the cards which fell into either of these units. The following table gives the scale of resemblance, the average M. V. corresponding to each unit of the

[2] I owe many thanks to Prof. Münsterberg, Dr. S. M. Graves, C. F. Hawkins, C. L. Hedden, W. W. Reed, Miss Wilkins; my colleagues in the laboratory and the rest of those who showed real friendship as well as a genuine interest in the promotion of science, when they condescended to sacrifice much of their valuable time in judging the cards.

scale, and the number of pairs of cards that entered into the construction of each unit.

TABLE 12

% S	0	25	35	45	55	65	75	80	85	100
Av. M.V.	0	12	12	13	12	11	9	6	4	0
No. of Cards	50	15	25	43	57	78	61	10	23	50

It will be remembered that in the case of the words I grouped the psychological judgments on the basis of structural similarity, but I had no such external guide for the grouping of the judgments rendered with respect to the picture post-cards. Hence, I adopted the following system of classification: All cards whose values ranged between 1 and 9% were put into one class, those that varied between 10 and 19% were put into another class, and so on for cards that varied between 20 and 29%; 30 and 39%; 40 and 49%, etc. In general, all cards whose values ranged 10x and $(10x + 9)$, where x is a positive interger, were grouped together, their average taken, and that average made to constitute a unit of the similarity scale. The construction of a series for the recognition experiment was then a simple matter. All that was necessary to do was to take from the filing cabinet an equal number of pairs from each group. So that in each series there would be 3 or 4 pairs of 0% S, an equal number of 20% S, 30% S, and so on.

EXPERIMENTS ON RECOGNITION WITH PICTURE CARDS

With my material thus standardized and classified, I proceeded to investigate with it the following three factors: (1) The relation between degree of similarity and recognitive ability. (2) The influence of N—the number of objects exposed on recognition. (3) The influence of t—the time of exposure on the recognitive process. The first factor was really our main concern; the other two were varied in order that we might discover the ideal conditions under which a definite mathematical relation might be established between similarity and ideational recognition. This condition, as we have remarked on a previous occasion, must be one such that, with the largest number of items exposed for the shortest possible time, the substitution of cards

of 0% S will be recognized 100% of the times, and the repetition of identical cards will also be recognized 100% of the times, or almost that often; while the substitution of cards of intermediate values would be recognized in some definite ratio to their similarity. What that ratio was is what we wished to find out.

For these experiments I used the apparatus described on page 15. The critical card was exposed among a fixed number of other cards, and after an interval of 20 seconds, the same setting was re-exposed with the variable card in place of the normal or with no change at all, as the case may have been. The position of different pairs of critical cards was varied from group to group, but that of the same pair was kept constant for all observers. The milieu for each alternate exposure, i.e. for each pair of critical cards was always new, and never was a card from one setting shown in another. Not only were the critical cards kept in the same position for each observer, but the entire pattern or layout of the setting was also kept intact for all ten subjects.[3]

I had 10 subjects for these experiments—all of them members of the Harvard Psychological Laboratory, and, for the most part, trained psychologists. Eight of the observers were men and two women.[4] Each of them came to me separately, at intervals of one week. The sitting with each observer lasted one hour, during which time an average of 15 or 20 judgments were recorded. All sittings took place between 9 and 1 o'clock.

Each series, comprising from 25 to 30 pairs of cards, was devoted to the examination of a different combination of N and

[3] An easy way to insure uniform conditions with respect to this matter is to paste the "fillers" on a cardboard, and to leave a vacant place, of the proper dimension, for the normal, which, after the first exposure, can be quietly removed and the variable put in its place. One should take care, however, that the loose critical cards lie flat against the background, or else the observers will learn to distinguish them from the "fillers" on the first exposure, and this, of course, will vitiate the experiment.

[4] For their participation in these experiments I am very grateful to Misses O. E. Martin and O. L. M. Seeley, to Drs. R. M. Elliott, R. C. Givler, H. S. Langfield, H. T. Moore, and Messrs. J. H. Picken, A. A. Roback, N. N. Sen Gupta, and E. C. Tolman.

t—size and length of exposure. I tried to have as many units of the similarity scale as possible represented in each series. Not always, however, was I successful in this, because it was difficult to find cards of very low and very high similarity, i.e. below 30% and above 80%. Had I been able to find such, I should have had a scale of 11 units, but owing to the lack of such cards the scale will be found to contain from 8 to 9 units. Inasmuch as each unit in a given series is represented by 3 or 4 pairs of cards, the recognitive value of that unit is based on 30 or 40 judgments.

Cards from two or three different series were exposed at each sitting so as to avoid the inequality that would result from improvement due to practice. In this manner one-half of all series were exposed during the first semester of 1912-1913, and the second half during the second semester. The 10 subjects who participated in this investigation were never allowed to see any of the cards either before or after the experiments, nor were they ever acquainted with their achievements.

The following tables embody the results of our investigation with the picture post-cards. They should be interpreted thus: The first vertical column contains the symbols whereby each pair of cards were designated; the second column, marked % S, contains the corresponding similarity of the variable card to the normal in that pair. The three columns under the heading "Distribution of Judgments", show how the substitutions were recognized by each of the ten observers, i.e. whether they were recognized positively (+), or not at all (—), or doubtfully (±), namely, with a degree of certainty that varied between 20 and 79%. The sixth column, marked % C, represents the per cent correct recognition, of course, they are judgments of "change" in all cases except those of 100% S, for these latter they are judgments of "no change". The next column shows the total number of judgments falling within each unit. The column following, marked Av. % S, contains the average per cent similarity of the several cards within the sub-group, while the column headed Av. % C gives the average per cent. correct recognition for those cards.

The last column needs a little fuller explanation. It will be remembered that I advised the observers not only to point out or to name the item which they thought was new, but also to mention what it had displaced. The ability to do both of these things is called perfect knowledge, (P. K.), and the percentage of times that the subjects were able to render such descriptions is recorded in the column % P. K. This, it should be noted, served to indicate whether the observers actually recognized the substitution or merely guessed it; also whether the variable card called up the normal by association, or whether the normal was carried during the interval as a memory idea, or as an image, or, finally, whether the variable tended to obliterate the normal from consciousness. Obviously perfect knowledge of substitution could exist only where the observers were 100% certain of their judgments of recognition. Hence the figures in the last column refer only to the judgments recorded under the sign +; they have nothing to do with the doubtful decisions. Where, therefore, as a result of the application of the Correction Formula a subtraction occurs from the total number of correct judgments that subtraction finds its justification in the existence of the doubtful judgments, (±), assuming that P. K. =100% in the given case.

Let us make a trial reading. Suppose we take a pair of cards that fall within the group of those that vary in similarity between 70 and 79%. Let it be No. 309. If we read across horizontally, we note that they were 74%S, that 6 subjects recognized the substitution definitely, that 2 failed to recognize it altogether, and that 2 were doubtful about it. By employing the formula

$$\frac{C+\frac{D}{2}}{C+W+D}$$

where C stands for the number of correct, D doubtful, and W wrong judgments, we note in the next column that the per cent correct recognition for card 309 is 70. Since 5 pairs of cards whose similarity varied between 70 and 77% were used, and since each substitution was judged 10 times, a total of 50 judgments were recorded. The average similarity of the cards within this group is 74%, and the average correct recognition of their substitutes is 67%. Hence we conclude that under the given conditions of the experiment—4 cards exposed 10 seconds—the replacement of one by another of 74%S will be recognized about 67% of the times. This conclusion is not based on the 50 judgments alone. It receives its strongest

support from the fact that there exists an inverse relation between recognitive ability and degree of similarity for the entire series, as the figures show, and that this inverse relation also holds for the particular unit in question.

The experiments are divided into different sets—A, B, C, etc., in each of which one factor is kept constant while the other two are varied. Thus in set A the exposure time—t, is kept constant while the number of objects, N, and degree of similarity, S, are varied.

Experiments A

Table 13

Series I: 4 Cards Exposed 10 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
286	0	10			100				
300	0	9			100	29	0	100	72
290	0	10			100				
33x	35	8		2	90	10	35	90	100
32x	41	9	1		90				
223	47	7	3		70	30	46	87	100
31x	49	10			100				
36x	55	8		2	90				
168	55	5	4	1	55	30	56	82	100
37x	58	10			100				
35x	63	9		1	95				
38x	66	3	3	4	45	30	65	78	95
263	67	9		1	95				
34x	70	5	1	4	70				
39x	73	8	2		80				
309	74	6	2	2	70	50	74	67	100
182	77	7	2	1	75				
299	77	3	5	2	40				
40x	91		8	2	10	10	91	10	
12a	100	8		2	90				
17a	100	10			100	30	100	97	
21a	100	10			100				

TABLE 14
Series II: 5 Cards Exposed 10 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
150	0	10			100				
18b	0	10			100	40	*0*	*100*	73
21b	0	10			100				
29b	0	10			100				
105	25	10			100	10	*25*	*100*	?
124	42	10			100				
131	44	5	4	1	55	40	*46*	*78*	92
163	48	6	3	1	65				
245	49	9	1		90				
97	50	9	1		90				
259	51	9		1	95				
8x	55	4	2	4	60	50	*54*	*76*	94
7x	57	4	4	2	50				
305	59	8	1	1	85				
85	60	7	1	2	80				
176	64	7	1	1	83				
2x	66	5	3	2	60	48	*64*	*65*	100
3x	68	4	4	2	50				
304	68	3	3	3	50				
4x	70	5	4	1	55				
262	71	8	2		80				
319	75	7	2		77	49	*74*	*54*	91
77	76	3	5	2	40				
5x	79	1	7	2	20				
1x	80		10		0	20	*81*	*25*	?
10x	81	4	4	2	50				
9x	94		9	1	5	10	*94*	*5*	
16a	100	10			100				
20a	100	10			100	40	*100*	*96*	
24a	100	9		1	95				
27a	100	9	1		90				

TABLE 15
Series III: 6 Cards Exposed 10 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
15b	0	10			100				
281	0	10			100	30	*0*	*100*	60
311	0	10			100				
221	45	9	1		90				
115	47	7	3		70	30	*47*	*82*	100
314	49	8	1	1	85				
159	50	7	1	1	83	19	*55*	*81*	91
45x	59	7	1	2	80				
47x	61	6	2	2	70				
41x	66	7	1	2	80	30	*64*	*73*	100
239	66	7	3		70				
44x	70	7	1	2	80				
172	73	5	3	2	60	30	*73*	*67*	?
42x	75	5	3	2	60				
49x	83	4	3	3	55	20	*85*	*40*	
46x	86		5	5	25				
1a	100	9	1		90				
2a	100	6	1	3	75	30	*100*	*88*	
3a	100	10			100				

On turning our attention to the main results of the three foregoing tables we find. (1) that there is a marked inverse relation between degree of similarity and recognitive ability; and (2) that recognition becomes more difficult as the size of the group increases. Series II as compared with Series III, seems to be an exception to the second statement. But this is because Series II was the first one experimented with, hence, the observers being entirely unpracticed, yielded lower results with it than with the larger exposure of Series III.

The results given in the next and subsequent Comparison Tables are based on the Av. % C modified by the Correction Formula. The letters N_4, N_5, N_6, ... N_x stand for the groups—the subscripts representing their size; while t_4, t_5, t_6, ... t_x represent the length of exposure. Therefore, N_4-t_{10} means a group of 4 cards exposed 10 seconds, etc.

TABLE 16

Comparative Per Cent Correct Recognition when Cards of the Same Degree of Similarity are Exposed for 10 Seconds in Groups of 4, 5, and 6

% S = ...	0	25	35	45	55	65	75	80	85	90	95	100
$N_4 - t_{10}$	100		90	87	82	78	67			9		100
$N_5 - t_{10}$	100	100		78	76	65	54	25			4	100
$N_6 - t_{10}$	100			81	80	72	66		38			100

EXPERIMENTS B

The next set of experiments were conducted along the same line as the previous ones, except that the exposure time was reduced from 10 to 7 seconds.

TABLE 17

Series IV: 4 Cards Exposed 7 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
149	0	10			100	20			
149x	0	10			100		*0*	*100*	70
107	23	9	1		90	10	*23*	*90*	?
145	32	9	1		90	10	*32*	*90*	?
87	40	10			100				
130	45	9	1		90	30	*44*	*85*	100
249	48	5	2	3	65				
63x	50	6	2	2	70	20	*52*	*78*	92
192	53	8	1	1	85				
74	62	8	1	1	85				
216	66	6	4		60	30	*65*	*65*	90
116	68	3	3	4	50				
70x	70	7	2	1	75	20	*72*	*63*	100
110	73	4	4	2	50				
323	88	1	7	2	20	10	*88*	*20*	
72a	100	9		1	95				
73a	100	9		1	95	30	*100*	*97*	
742	100	10			100				

TABLE 18
Series V: 5 Cards Exposed 7 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
61x	0	10			100				
62x	0	10			100	30	0	100	40
63x	0	10			100				
217	44	9		1	95				
50x	46	6	3	1	65	40	46	84	94
106	47	10			100				
56x	48	7	2	1	75				
104	50	9	1		90				
57x	53	5	3	2	60	30	53	75	95
99	55	7	2	1	75				
53x	67	7	3		70				
54x	67	4	3	3	55	30	68	70	94
52x	69	8	1	1	85				
118	70	4	5	1	45	20	74	55	92
55x	78	5	2	3	65				
51x	80	6	4		60				
303	82	2	6	2	30	30	82	40	100
326	83	4	6		40				
59x	90	2	6	2	30	10	90	30	
58a	100	9		1	95				
4a	100	10			100	30	100	93	
5a	100	8	1	1	85				

TABLE 19
Series VI: 6 Cards Exposed 7 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
148	0	9	1		90				
16x	0	10			100	30	0	97	
324	0	10			100				
141	23	7		3	85	10	23	85	?
63x	41	4	2	3	60				
62x	43	6	1	3	75	39	47	65	92
227	47	6	3	1	60				
16	49	6	4		60				
65x	52	9	1		90				
182	53	5	3	2	60	30	54	62	100
71x	58	2	5	3	35				
199	60	6	2	2	70				
52	60	6	2	2	70				
52	61	5	3	2	60	40	64	61	80
48	67	6	3	1	65				
179	69	4	4	2	50				
62	70	1	6	3	25				
91	74	1	7	2	20	29	72	22	
184	75		5	4	22				
119	80	2	5	3	35				
66x	87	1	7	2	20	30	84	20	
71	86		9	1	5				
15a	100	8		2	90				
22a	100	8		2	90	30	100	92	
24a	100	9		1	95				

TABLE 20
Comparative Per Cent Correct Recognition when Cards of the Same Degree of Similarity are Exposed for 7 Seconds in Groups of 4, 5, and 6.

% S = ...	0	25	30	45	55	65	75	85	90	100
$N_4 - t_7$	100	90	90	85	78	65	63—		19	100
$N_5 - t_7$	100			84	74	69	54	39	29	100
$N_6 - t_7$	100	87		66	63	61	22	19		100

Here we note once more that on the whole recognitive ability varies inversely (1) as degree of similarity, and (2) as the number of items exposed.

The best way to compare one series with another, when t is constant, is to divide the sum % C of one by the sum % C of the other which exist for the *same* units of similarity,—discarding the values of C for 0% S and 100% S. Thus the units of similarity common to series IV and V, i.e. N_4 and N_5, are 45, 55, 65, 75, and 90. Now Σ % C for $N_4 = 310$, and Σ % C for $N_5 = 309$.

Therefore, $N_4 : N_5 = 1 : 1$.
Similarly, $N_5 : N_6 = 1 : .75$.
and $N_4 : N_6 = 1 : .78$.

Experiments C

The third set of experiments still follow along the same lines, only this time the period of exposure is once more reduced—from 7 to 5 seconds. Here we add a group of 3 cards to those of 4, 5 and 6, in order that we may compare the difference between exposing 6 cards for 10 cards, (see Table 15), and half that number for half that time.

Table 21
Series VII: 3 Cards Exposed 5 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
67x	0	10			100				
68x	0	10			100	30	0	100	100
73x	0	10			100				
220	39	10			100	20	39	100	95
273	39	10			100				
55	40	8	2		80				
84	45	6	1	3	75	40	44	79	100
180	45	7	2	1	75				
318	45	7		3	85				
133	51	9		1	95				
29	52	7	2	1	75	40	54	77	89
33	57	5	1	4	70				
255	57	5	1	4	70				
54	62	5	3	2	60				
4	66	5	3	2	60	30	64	72	93
170	66	9		1	95				
93	70	3	4	3	45				
47	74	5	2	3	65	39	75	53	100
61	77	2	2	6	50				
117	78	4	4	1	50				
14	81		5	5	25	20	81	50	100
253	81	6	1	3	75				
20a	100	9		1	95				
21a	100	8		2	90	40	100	94	
26a	100	9		1	95				
27a	100	9		1	95				

TABLE 22
Series VIII: 4 Cards Exposed 5 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
146	0	9		1	95				
16b	0	10			100	40	0	100	63
17b	0	10			100				
28b	0	10			100				
127	30	7	3		70				
289	30	9	1		90				
193	38	9		1	95	40	34	85	84
89	39	8	1	1	85				
76	42	8		2	90	20	43	82	100
9	45	6	1	3	75				
88	50	4	3	3	55				
96	57	5	1	4	70	30	55	62	90
30	58	5	3	2	60				
1	60	4	3	3	55				
151	62	3	1	5	61	39	64	55	87
82	67	5	4	1	55				
36	68	4	4	2	50				
165	70	3	3	4	50				
72	70	4	5	1	45	40	74	46	91
126	78	5	3	2	60				
40	78	2	6	2	30				
79	80	1	7	2	20	20	80	35	100
109	80	5	5		50				
28a	100	10			100				
29a	100	9		1	95	40	100	95	
30a	100	9		1	95				
31a	100	8		2	90				

TABLE 23
Series IX: 5 Cards Exposed 5 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
229	0	8	1	1	85				
232	0	9		1	95	30	0	90	44
237	0	10			100				
166	20	6	3	1	65				
167	23	6	3	1	65	40	25	79	75
215	26	9		1	95				
207	29	9	1		90				
103	33	6	3	1	65	19			
174	39	6		3	83		36	74	91
100	44	7	3		70				
186	44	6	2	2	70	30	46	67	100
59	49	3	1	6	60				
236	53	7	1	2	80				
6	54	4	4	2	50	40	55	61	91
18	57	6	3	1	65				
162	57	5	5		50				
21	60	4	3	3	55				
32	64	1	6	3	25	30	64	35	100
48	67	2	7	1	25				
49	70		6	4	20				
161	74	2	8		20	20	73	20	100
42	80	3	6	1	35				
37	89		9	1	5	20	85	20	
32a	100	9		1	95				
33a	100	8		2	90	40	100	91	
34a	100	9		1	95				
35a	100	8	1	1	85				

TABLE 24
Series X: 6 Cards Exposed 5 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
29b	0	9	1		90				
30b	0	10			100	30	0	90	22
31b	0	8	2		80				
246	30	8	2		80				
81	32	6	4		60	40	35	74	92
270	37	8	1	1	85				
95	39	6	2	2	70				
198	47	7	1	2	80	20	48	70	83
78	48	4	2	4	60				
23	50	2	6	2	30				
173	54	4	3	3	55	30	53	40	100
8	58	3	6	1	35				
10	60	2	6	2	30				
258	65		8	2	10	30	64	27	60
75	66	3	5	2	40				
241	72	1	7	2	20				
136	77	1	8	1	15	30	75	23	66
140	77	2	6	2	30				
108	80	2	7	1	25				
151	82	1	8	1	15	40	83	21	100
256	83	2	7	1	25				
73	86		6	4	20				
38a	100	7		3	85				
39a	100	10			100	40	100	91	
40a	100	9		1	95				
41a	100	8	1	1	85				

TABLE 25
Comparative Per Cent Correct Recognition when Cards of the Same Degree of Similarity are Exposed for 5 Sec. in Groups of 3, 4, 5 and 6.

% S = ...	0	25	35	40	45	50	55	65	75	80	85	100
$N_3 - t_5$	100			99	78		76	71	51	48		100
$N_4 - t_5$	100		86	82			62	54	45	34		100
$N_5 - t_5$	100	87	80		71		64	37	20		20	100
$N_6 - t_5$	100		80			74	44	30	23			100

If we compare any two series by taking those values of C which exist for the similarity units common to them, (discarding the extreme ends), we find further proof of what may be called the second law of recognition, namely, that recognitive ability

varies inversely as the number of objects perceived. Is there a definite mathematical relation between N and C, where N stands for the size of the group and C for correct recognition? Of course, much will depend on time of exposure—t. But since this third factor is constant in the above series it may be cancelled out. If we do so, we find, with respect to the remaining factors, that their product in any given series divided by their product in any other series is always equal to a constant K, the value of which is $1 \pm .1$.

That is, $$\frac{N_m C_m}{N_n C_n} = 1 \pm .1 .$$

Thus suppose we take N_3 and N_4. The similarity units common to them are 40, 55, 65, 75, 80. Now the sum of % C common to these units for N_3 is 345, and for N_4, 277. Therefore, $$\frac{C_3 N_3}{C_4 N_4} = \frac{345 \times 3}{277 \times 4} = .94 \ldots (1) .$$

Likewise, $$\frac{C_4 N_4}{C_5 N_5} = \frac{247 \times 4}{201 \times 5} = .98 \ldots (2) .$$

while $$\frac{C_5 N_5}{C_6 N_6} = .93, \ldots (3) \qquad \frac{C_3 N_3}{C_6 N_6} = 1.00, \ldots (4)$$

$$\frac{C_4 N_4}{C_6 N_6} = .95, \ldots (5) \qquad \frac{C_3 N_3}{C_5 N_5} = .86, \ldots (6)$$

Of these six equations only one—(6)—varies considerably from the standard equation. Obviously, in this particular combination, % C for N_3 is too low. If we turn to the individual values of % C in this group, we find that the value for 45% S is only 78, whereas the one immediately before it is 99 and the one immediately following is 76. For this reason, then, and because the other equations give results that are so near unity, we may conclude that the standard equation is correct.[5]

[5] Whether or not the foregoing results are due to chance can be easily determined by asking ourselves the following question: Given four independent variables—a, b, c, d,—what is the probability that the combination of any two of them will always give rise to the same event?

The possible ways in which the 4 variables can combine taken 2 at a time, are 6. That is, they can give rise to 6 different events. Suppose we represent them thus:

ab = A, be = B, cd = C, ac = D, ad = E, bd = F.

Now since $\frac{C_3 N_3}{C_6 N_6} = 1$, we get, by transposing, $C_3 N_3 = C_6 N_6$.

Therefore, $\frac{C_3}{C_6} = \frac{N_6}{N_3}$; similarly, $\frac{C_4}{C_6} = \frac{N_6}{N_4}$, and in general, $\frac{C_m}{C_n} = \frac{N_n}{N_m}$.

Whence we may conclude that under the conditions of the experiment, and with a constant exposure time of *5 seconds,* the recognitive ability of one group is to another inversely as the size of the first is to the size of the second. Thus if a card of x% S is recognized y% of the times in a group of 3 items exposed for 5 seconds, then in a group of 4 times it will be recognized ¾ y% of the times.

If we now take the values of % C obtained with $N_6 t_{10}$, (Table 15), and compare them with those of $N_3 t_5$ corresponding to the same units of similarity, we find that $\frac{\Sigma C_6}{\Sigma C_3} = 1.04$. This indicates that for cards exposed at the rate of one per 1⅔ sec., the doubling of the time of exposure fully compensates for the doubling of the number of cards exposed—within certain limits of course. This fact should be kept in mind, for it will be shown that this relation does not hold for cards exposed at the rate of one per 1 sec.

Experiments D

The final set of experiments were made with cards exposed at the rate of 1 per sec. in groups of 3, 4, 5 and 6. The following tables give the itemized results,[6] while Table 29 contains the main results modified by the Correction Formula. It is on the basis of these latter that the curves in Plate II are drawn.

Since we do not know beforehand which one of these occurrences ab will give rise to, and since it *must* give rise to one of them, the probability that it will produce its effect, A, let us suppose, = 1. But now what is the probability that bc will give rise to A and not to something else, such as B, or C or D? Manifestly ⅙. Likewise the chance that cd will give rise to A only, = ⅙; and so on for ac, ad and bd. Therefore ,the probability that all combinations will give rise to the same event on the basis of chance $= 1 \times \left(\frac{1}{6}\right)^5 = \frac{1}{7776}$. That is, the odds in favor of our results being due to cause and not to chance are 7775 to 1.

[6] For 5 cards exposed for 5 seconds see Table 23.

These curves show the relation between % C and % S obtained with cards exposed at the rate of 1 per sec. and words exposed at the rate of 1 per ½ second.

TABLE 26

Series XI: 3 Cards Exposed 3 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
33b	0	10			100				
34b	0	10			100	40	0	99	90
269	0	9		1	95				
260	0	10			100				
228	19	10			100	20	20	100	90
225	27	10			100				
153	33	10			100				
195	33	10			100	30	34	98	100
268	35	9		1	95				
12	45	6	2	2	70	20	46	78	100
205	47	8	1	1	85				
121	54	5	4	1	55	20	55	58	100
133	57	5	3	2	60				
68	60	6	3	1	65				
132	63	2	3	5	45	30	62	50	95
53	64	2	4	4	40				
7	70	6	2	2	70				
46	72	3	4	3	45	30	72	46	100
19	73	1	6	3	25				
178	82	2	6	2	25				
247	85	1	9		10	40	85	20	100
70	87	1	6	3	25				
152	88	1	8	1	15				
42a	100	10			100				
43a	100	9		1	95	40	100	93	
44a	100	8		2	90				
45a	100	8	1	1	85				

TABLE 27
Series XII: 4 Cards Exposed 4 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
36b	0	10			100				
230	0	10			100	30	0	97	70
233	0	9	1		90				
226	20	9		1	95				
224	25	9		1	95	30	24	97	92
185	27	10			100				
209	30	9	1		90				
211	30	8	1		88	39	33	83	100
196	35	7	2	1	75				
222	39	7	1	2	80				
28	45	9		1	95	20	46	82	85
210	47	5	1	4	70				
254	50	4	2	4	60				
16	52	8	1	1	85	30	53	68	88
234	56	5	3	2	60				
50	63	5	3	2	60				
155	63	1	5	4	30	40	64	45	80
191	65	6	4		60				
11	69	1	5	4	30				
57	70	2	3	5	45	20	72	35	—
35	73	1	6	3	25				
66	81	1	8	1	15				
204	83	2	5	3	35	30	84	22	—
257	89		7	3	15				
46a	100	9		1	95				
47a	100	9		1	95	40	100	95	
48a	100	10			100				
49a	100	8		2	90				

TABLE 28

Series XIII: 6 Cards Exposed 6 Sec.

Card No.	%S	Distribution of Judgments +	—	±	%C	Total Judgments	Av. %S	Av. %C	% P.K.
147	0	7	1	2	80				
153	0	8	1	1	85	40	0	86	37
231	0	8	2		80				
250	0	10			100				
219	25	10			100				
208	25	7	1	2	80	40	26	81	93
183	27	8		2	90				
176	28	4	3	3	55				
200	34	8		2	90	20	36	77	100
98	38	6	3	1	65				
143	43	3	4	3	45				
25	45	5	3	2	60	40	45	56	93
26	45	5	3	2	60				
69	46	3	1	6	60				
139	53	2	4	4	40	20	55	38	—
169	56	2	5	3	35				
63	63	2	5	3	35				
65	63	2	4	4	40	40	65	34	90
128	65	1	8	1	15				
111	67	2	3	5	45				
112	72	3	3	4	50				
122	76	2	6	2	30	40	76	30	80
39	77	1	6	3	25				
44	78	1	8	1	15				
212	84	2	8		20				
321x	85	1	8	1	15	40	86	14	—
298	87		10		0				
243	88	2	8		20				
50a	100	7	1	2	80				
51a	100	8		2	90	40	100	88	
52a	100	8	1	1	85				
53a	100	8		2	90				

TABLE 29

Comparative Per Cent Correct Recognition When Cards of the Same Degree of Similarity are Exposed at the Rate of 1 per Second in Groups of 3, 4, 5, and 6.

% S = ...	0	25	35	45	55	65	75	85	100
$N_3 - t_3$ = ...	100	100	97	77	57	49	45	18	100
$N_4 - t_4$ = ...	100	99	85	83	69	45	35	22	100
$N_5 - t_5$ = ...	100	87	80	71	64	37	20	20	100
$N_6 - t_6$ = ...	100	88	83	61	44	33	31	14	100
Av. = ...	100	93	86	73	58	41	33	18	100

From these figures we find that the sum of % C of each group—discarding the values for 0% S and 100% S—is

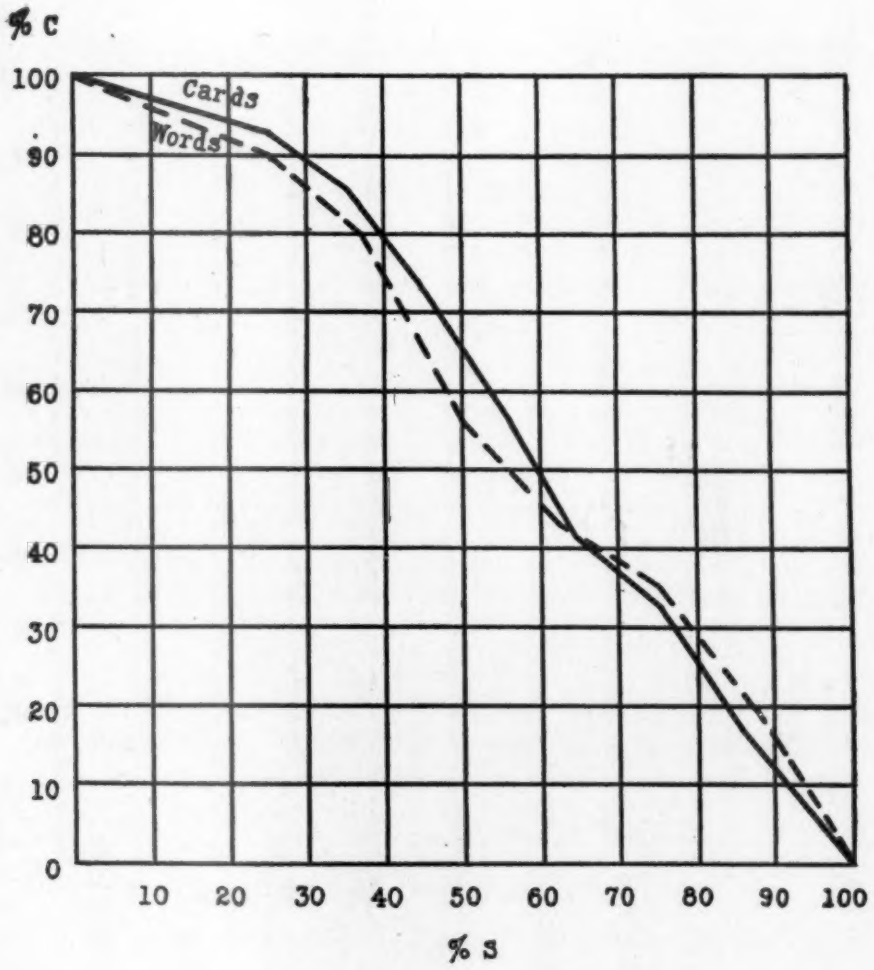
$$\Sigma C_3 = 443, \quad \Sigma C_4 = 438, \quad \Sigma C_5 = 379, \quad \Sigma C_6 = 353 .$$

Whence it appears that recognitive ability varies inversely as the number of objects exposed when the length of exposure for each object is the same and not more than 1 second. This may be called the third law of recognition.

On the other hand, it was found; (page 79), that no diminution in recognition occurs if 1⅔ seconds are added to the exposure time for each additional card. Hence, we may conclude that under the conditions of the experiment, size of exposure stands to length of exposure in the ratio of $1 : (1 + \frac{2}{3} - x)$, when $x < \frac{2}{3}$.

PLATE II

Curves Showing Av. % C for Cards Exposed at the Rate of 1 per Sec. in Groups of 3, 4, 5, and 6, and Words Exposed at the Rate of 1 per ½ Sec. in Groups of 8.



We have thus far considered the influence of three factors on the process of recognition: (1) degree of similarity, (2) length of series when exposure time is constant, (3) length of series when exposure time is proportionate. And we have found that recognitive ability varies inversely as each of these moments. There is still a fourth factor to be considered, namely, the influence on recognition of the varying periods of exposure when length of series is constant.

The following table contains data from Tables 16, 20 and 25, arranged in such a way as to show the % C for groups of 4, 5, and 6 cards when each was exposed for 10, 7 and 5 seconds successively. The reader should remember that there were three series of each size, so that altogether 9 series are represented. In order to make the comparison meaningful we employ only those values of C which have the same units of similarity in all 9 series. Hence the figures in the last column represent Av. % C for S = 45, 55, 65, and 75%.

TABLE 30

Influence of Time of Exposure (t) when Size of Group (N) is Constant.

	% S = ...	25	35	40	45	55	65	75	80	85	Av. % C for 4 units of S
N_4	t_{10} = ...		90		87	82	78	67			79
	t_7 = ...	90	90		85	78	65	63—			73
	t_5 = ...		86	86	82	62	54	45	34		61
N_5	t_{10} = ...	100			78	76	65	54	25		75*
	t_7 = ...				84	74	69	54		39	70
	t_5 = ...	87	80		81	64	37	20		20	48
N_6	t_{10} = ...				81	80	72	66		38	73
	t_7 = ...	87			66	63	61	22		19	53
	t_5 = ...		80		74	44	30	23		21	43

* Interpolated as the probable value if this series had not been exposed to the observers at the beginning of the experiment, i.e.. when they were still unpracticed.

From these figures we gather that for any given value of N recognition varies directly as the length of exposure. This may be called the fourth law of recognition. It seems that it makes little difference whether groups of 4 or 5 cards are exposed for 10 and 7 seconds successively. A decided difference first appears when t = 5. This should not be sur-

prising, for if the exposure time is long enough to enable complete or even partial memorization of the group, then it does not matter whether one extra item is added or not.

There is another kind of comparison to be made. On the one hand, we may let C = 100% when t = 10 sec. for every value of N, on the other hand, we may let C = 100% when N = 4 for any value of t. In this way we shall obtain results which will enable us to tell at a glance whether the exposure of the same number of cards for periods varying in the ratio of 10:7:5 sec. gives the same results as the exposure for equal units of time of groups varying in the ratio of 4:5:6 cards.

In the following table part A shows the gradations of C when N is constant and t varies; part B when t is constant and N varies. The calculation in each case is made for the same units of the similarity scale.

TABLE 31

A
Effect of t on Recognition

	N_4	N_5	N_6
t_{10}	100	100	100
t_7	92	94	73
t_5	78	72	59

B
Effect of N on Recognition

	t_{10}	t_7	t_5
N_4	100	100	100
N_5	96	97	88
N_6	90	72	70

Here we find that for any value of N, the reduction of t first by 30%, than by 50% produces a larger variation in % C than the increase of N first by 25% then by 50% does for any value of t. This is only another way of proving that for each additional item added to a group of x items exposed for y seconds, we must add not 1 second, but 1 + a fraction of a second if we wish to obtain the same results. In this connection see conclusion on page 83.

And now if we let % C obtained from the combination of N_4-t_{10} = 100, the relative values of any combination of N and t can be seen from Table 32.

TABLE 32

Relative Values of N_x — t_y Determined to the Base of N_4 — t_{10}

	N_4	N_5	N_6	N_3
t_{10}	100	95	92	
t_7	92	90	67	
t_6			53	
t_5	78	68	54	89
t_4	73			
t_3				72

Whence we derive the following equations or pairs of equivalent formulae:

$$(1)\quad N_4 - t_7 = N_6 - t_{10}$$
$$(2)\quad N_4 - t_4 = N_3 - t_3$$
$$(3)\quad N_5 - t_5 = N_6 - t_7$$
$$(4)\quad N_5 - t_7 = N_3 - t_5$$
$$(5)\quad N_6 - t_5 = N_6 - t_6$$

Of these, the analytical tables indicate that the most ideal combination of N and t, i.e., those which give the most evenly graded correlations between C and S, are: N_6-t_7, N_4-t_5, N_5-t_5, N_4-t_4 and N_6-t_6. The last one being the best. But as the closest one-to-one correspondence obtains between N_4-t_4 for post-cards and N_8-t_4 for tri-syllabic words, these two may be used with advantage for practical purposes.

This is the goal of our quest.

Summary of Tests with Picture Post-Cards

And now if we bring all our results together, we obtain Table 33, which shows the average per cent correct recognition for each value of S determined on the basis of all judgments rendered for all substitutions of that particular S.

TABLE 33

% S = ...	0	25	35	45	55	65	75	80	85	100
Total No. Judgments.....	409	150	228	379	389	447	437	90	230	470
% C = ...	100	92	87	77	67	55	45	34	21	100
Total + Judgments	389	77	184	227	228	201	122	12	22	
% P.K.	61	93	95	95	93	91	94	?	?	

This is the curve we should expect to obtain when groups of 4 items are exposed for 5 seconds.

There are two interesting questions that present themselves in connection with the above figures. (1) Why is it that the recognition of a 25% substitution is almost as high as that of a 0% substitution? (2) Why is it that % P.K. is so low when S = 0%? Both of these facts came out in the word experiments as well as in these latter tests.

With regard to the first question the only explanation to be offered is that similarity in the visual realm must reach a certain minimal value before confusion will be produced in the recog-

nitive consciousness. This conditon is entirely analogous to what we have in sensation— the stimulus must reach a certain minimal intensity before it will produce a just perceptable sensation. Likewise in ideational discrimination—no confusion between two stimuli will result until the similarity reaches at least 20%. Beyond that recognition seems to vary inversely as similarity in the ratio of X: (100-X) expressed in terms of percentage.

The other question demands more careful consideration. It has already been remarked (page 42 ff) that the totally dissimilar impression seems to wipe out all memory of the previous one. The theory advanced was that owing to its great dissimilarity, it sets up a totally different brain process which, for the time being, eliminates the one previously induced.

Introspection bears this out. Substitutions of O similarity invariably produced a shock. Thus in Se IX-237[7] the subjects say: A: + (+) V is new, 100% sure. I had a general impression of all cards and V did not fit in with the rest. It gave me a shock when I saw it. I know what was there before.

B: + (—) V is new, 100% certain. I knew during the interval what card was there before, but this card, V, knocked it right out of memory. This new picture post-card is so prominent that it seems to inhibit the other one every time I make an effort to call it up.

Se. III-311. A: + (—) V is new, 100% sure. I never saw it before. It seems like a thing in a wrong setting; it does not harmonize with the others. It gives me a new kinaesthetic feeling. I cannot recall what was there before.

Se. V-63x: H: + (—) As soon as the shutter went up the first time I went over all the cards and read some of their writing, portions of which I carried in memory during the interval, as well as the images of three cards. When the shutter went up the second time, I looked at some and found them familiar, but when I came to V it gave me the impression of a vacant lot among a group of buildings. It was like something which lacks meaning. If there had been no card there at all,

[7] In this and subsequent readings Se. stands for 'Series,' the Roman numeral for the number thereof, and the Arabic for the card number.

I don't think the feeling of emptiness produced in me would have been more pronounced.

Frequently the subjects would declare that they had a vague idea of what was there before, but they could not call it up in memory. Yet in some instances they would succeed in recalling N after an interval of a minute or two. Sometimes they would make a conscious effort, at other times they woud remain passive, and N would come back of its own accord.

This occurrence led me to believe that perhaps they did not observe the cards as separate entities, but took in the group as a whole; in the same sense that one regards a painting as a composition and not as so many isolated figures or patches of color. Of course, this question once more reverts to our main problem. The fact that deceptive substitutions could be made with cards of 35 or 45% similarity shows that the single cards at least were carried as entities, for if their contents had been carried piece-meal no deception would have been possible at all.

That this was true, to a less extent, of the group as a whole, I found out in the following manner. When a zero substitution had been made, and the observer declared, on the second exposure, that he was positive V was new but could not recall what had been there before, I would remove one of the fillers and put N in its place, still leaving V where it was. Exposing this group once more, the subject would say, "Well, this is the same group you showed me just before, i.e. the second time." Whereupon I would take V out, put N into its original place, and return the filler. Exposing the group again, the observer would exclaim, "Oh yes, there is N. That's the card I could not recall." Or, "The whole group is now the same as the one you showed me on the first exposure. I recognize all the cards now that they are in their original positions."

Occasionally on the third exposure the subject would assert that N, being displaced, is a new card, and only when it was returned to its original place was it recognized as the original card, i.e. as the missing item. The following cases are characteristic of the many that occurred.

Se. III-311
4 (A-B)-O%S

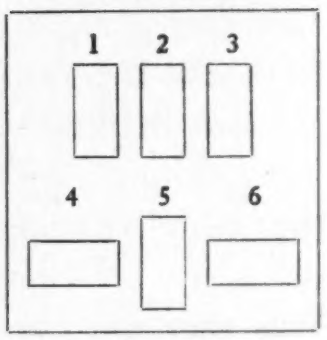


Fig. XI.

I: + (—) Exp. 2:[8] 4B is new, 100% certain. I don't know what was there before.

Exp. 3. (6A-4B): Well, about four of the cards are the same as in the second exposure. There is one new one—the lower right—6A. I don't remember having seen it before.

Exp. 4. (4A): This is what I saw on the first exposure, and by "this" I mean the whole group. But I also know now that this lower left card, 4 A, is what I saw the very first time. But I could not recognize it when it was put in a different position. I don't know why, perhaps I remembered it in relation to the others.

J: + (—) Exp. 2: 4B is new, certain. I cannot remember what was there before. I don't think I could recognize A.

Exp. 3. (6A-4B): 6A looks like the replaced card, but I am not sure.

Exp. 4. (4A): I should say with more positiveness that 4A is what was there originally. The feeling of recognition is stronger when I see it in this position. There is a synthesis of the feeling of familiarity.

Se. X-67X
3 (A-B)-O%S

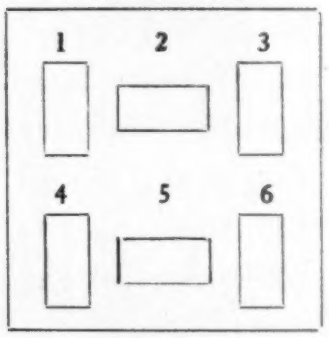


Fig. XI.

E: + (—) Exp. 2: 3 B is new 100% sure. I have not the faintest idea what 3 A was.

Exp. 3: (1 A-3 B): 1 A seems new. I have not seen it to-day.

Exp. 4: (3 A): Oh yes, 3 A is the card I saw on the first exposure. The reason why I recognize it this time and did not when you had it in position 1, is that the cards associate themselves in their respective positions, so that the whole group is like a design to me. Hence, when you put A, which I originally saw in position 3, into position 1, it looked strange; but when you put it back into its original position it seemed to fit in, and I got the feeling of familiarity for the whole arrangement as such. This is true of all cards

[8] Exp. 1, Exp. 2, etc., means first exposure, second exposure, etc.

except the gaudy ones, or those that are distinctive, such as portraits.

I: + (—): Exp. 2: 3 B is new. I am certain. I cannot say what was there before.

Exp. 3: (1 A-3 B): 1 A is new. I remember having seen 1 A some time ago, but when or where I cannot recall.

Exp. 4: Now it is all right. That is what I saw on the first exposure. It did not strike me at all that A was the displaced card when I saw it in position 1, i.e. on the third exposure. But now that I see it in its original position it comes back to me very strongly.

From these representative cases we see that it is the preserved arrangement of the cards which often facilitates recognition. If a card is displaced, it appears strange; if it is put back into its original place it looks familiar. In short, keeping the arrangement intact strengthens recognition. Now this cannot be explained on any other hypothesis but that every visual complex sets up a unified brain process; and if that same brain process is reinstated a second time in its entirety recognition will occur, if not, recognition will not occur.

What is true of the group as a whole is equally true of the single card. If there is no similarity whatever between the two critical cards, then the perception of the second, setting up a totally different brain process from that of the first, naturally destroys all memory of the first. To be sure this phenomenon does not happen every time. According to our figures it occurred in 39% of the cases. This is large enough a percentage, however, to justify the conclusion that, of two totally dissimilar visual impressions successively experienced, the later tends to inhibit the earlier. I say justify, because only a very small amount of similarity is required to produce almost complete recall. In these experiments substitutions of 25% S had a P.K., i.e. recall value of 93%.[9]

[9] For the metaphysical significance of these facts, see my article on The Fitness of the Environment for the Continuity of Consciousness, *Jour. of Phil. Psy. and Sc. Meth.*, Vol. XI, No. 16.

Methods of Recognition

The method of recognition varied with different individuals as well as with different cards. But objectively it was determined by two general conditions. Either the new card would be recognized as new because it lacked something that was remembered from the old card; or else it would be recognized as new because it had a new element in it. Subjectively, the recognition of the new card arose from the fact that either it produced a jolt—a shock of strangeness, or else it induced a different mood, or it produced a different kinaesthetic feeling, or it did not fit in with the image of the first card. If there was any similarity at all between N and V, the sight of the latter would call up the generalized image of the former. Thus, if N were the picture of a blue bell swinging to the right and V the picture of a violet bell swinging to the left, the sight of V would revive the memory idea of having seen a bell before, but the subject would not be able to say whether that bell was swinging in a different direction or was differently colored.

Certain artifices were resorted to by some of the observers at an early stage of the investigation, namely, they would try to select earmarks—certain distinguishing features from each of the cards presented on the first exposure, and carry these in memory in the hope that if a substitution were made, it would lack the earmark. But they soon gave up in despair, for the cards contained so many different elements that the mere task of deciding which one should be chosen for retention was bewildering. And so they fell back on the general impression. Even the two subjects who continued to the end of the experiments to select what they thought were earmarks, did not do better in the matter of correct recognition than two or three others who relied on their general impression. The reason is that very often the earmark was no earmark at all. Was it a word that they picked upon? then not infrequently the substituted card would contain that same word. Was it a tiny monogram in a remote corner of N? then very often

that same monogram would be found in the corresponding corner of V.

The extent to which the process of recognition investigated here was ideational is shown by the amount of intellectualization that went on in the minds of the observers as they looked at the first exposure: Processes of association, suggestion, pleasantness, unpleasantness were set up; some cards impressed them as sentimental, others as ludicrous, some were neat, others gaudy, some were very pretty, others decidedly ugly. In short, a distinct and unique idea was induced by each card, so much so that very often the observer would actively conceptualize the cards by classifying them in internal speech. That is to say, the content of the card, or better still, the impression produced by it would be given a name, a label. Is there anything that can be more representative of the life process? The appearance of one person "strikes" me as neat, i.e. causes me to attach ideationally the label of neatness to him, another person strikes me as careless; one as intelligent, another as stupid; one as having a firm character, another as a rake.

A few cases of introspection will bear this out.

Se. IV-192: B: +: V is new, 100% sure. The cupid is turned in a different direction. I had internal speech saying to myself, "Bridge, wagon." This internal speech comes with cards that are easily named. With other cards it comes only after their meaning has been realized.

E: —: No change, certain. I had inner speech when I first looked at the cards. Thus I had the ideas—and I think I said to myself, "Heart in the wheel-barrow, water wagon, bridge over the Charles River". These things I said to myself more or less completely. I don't think I had any articulation. Inner speech comes only when my attention is very active. Sometimes the inner speech returns during the interval when the image comes up.

Se. VI-106: J +: V is different. It has a different form. I am certain. I had images of all. When I first looked at the cards I had the ideas "Negro, engagement, law-abiding," while the card with the lavender color on it gave me an associa-

tion. In general, whenever I am in the mood, I make comments on the cards—or rather feel myself taking an active part in the ideational processes they set up, just as I do when I am out in the street sight-seeing.

A: ?: I take into account the concept of the card, i.e. the story it tells, not merely its lines and colors as bare lines and colors. A change of ideas is very potent with me. I recognize the change when I notice that the new card tells a slightly different story.

But whether or not inner speech and active classification accompanied the act of perceiving, the impression that the observers carried away with them, from the first exposure, was invariably in a conceptualized form.

It was interesting to watch the conflict between the feelings of familiarity and strangeness which were induced by the same card. Some aspects of the card, the observers would say, look familiar, others strange. At such times some of the subjects would speculate as to whether the new element was simply the result of completer perception than was possible on the first exposure or whether it was the distinguishing mark of a new card. The kind of judgment that would be rendered in such cases would be determined by the relative strengths of the two feelings. Thus one subject says for Se. XII-155.

C +: V is new. I am positive. Some parts look familiar, but the feeling of strangeness I get from it is strongest. It occasionally happens that a new element crops out in a card, yet I do not say the card is new for that reason because the other elements in it are so familiar that they exclude such a judgment.

On the other hand, we have such cases as the following:

Se. XII-234: D —: On the first exposure I read the words, "St. Patrick's Day", on the card in the upper right hand corner. There was something else on that card, but I could not make out what it was before the shutter went down. Now, on the second exposure, I see that the words on the card (V) are exactly the same, but I also see that it has two children on it. Therefore, I cannot say whether this is a case of the com-

pletion of an apperception or whether it is a new card. I shall say, however, that there is no change.

But there was a change. The two cards contained exactly the same inscription but the figures were entirely different. Now this observer, D, was one of those who relied on earmarks for recognition. He failed in this case because the earmark he selected was no earmark at all inasmuch as it was common to several things.

Sometimes the recognition of a new item would be affected by logical inference. Thus a subject may see card A with phrase B on it, and he later sees exactly the same card with a slightly different phrase, say one word altered. Knowing that the two phrases may function equally well for the content of A, he infers that the latter card is new.

The number of images that an individual carries during the interval bears no relation to his recognitive ability. Indeed, three of the observers would make no endeavor to recall images during the interval, because, as they said, such an attempt always caused mental confusion. Or sometimes the images of two or three items from as many different cards would fuse into one complex. These observers sat in a passive state during the interval. Two of them were among the poorest in ability to recognize, while the third was among the best.

Let us take a typical case. The card in question is Se. IX-235; its similarity is 75%. The standard (N) is a general card with the phrase, "Best wishes" written on top. In the background is a stately farmer's mansion. A hill with its downward slope to the bottom of the card. A stream of water runs down the slope. In the foreground stands a little girl, dressed in white, holding a bouquet of red flowers in each hand. She faces toward the right. The variable is the same as the standard except that the phrase now reads, "Many happy returns of the day." The farmer's house is of a different type. The child is now dressed in red, she faces slightly to the left and holds two bouquets of violets in her hands.

Here is how some of the subjects reacted to the substitution.

A+ : I think the child in 3 A was in a different position.

I get a kinaesthetic shock from this card (3 B). I get the same sensation as when one first thinks of the right hand and then of the left. At first, attention was focussed to the right, now I find it focussed to the left. I do not know what other differences there are, though I had images of all. I will say 3 B is new.

C +: 3 B is new, certain. I had three images, but the moment the shutter went up the second time they vanished, yet the sight of each card brought its image back. Also the instant I saw 3 B the image of 3 A flashed into my mind. I notice that this is a different girl, she holds different flowers, and stands in a different position.

F —: No change. I had no images. I tried to think of 1 and 2 during the interval because I thought one of them would be changed, but the more I thought of them the more confused they became, therefore I dropped them from thought altogether.

I —: No change, certain. On the first exposure I got a general impression from them. During the interval I remembered with regard to the lower left card, (3 A), that there was a child, a hill, a bunch of flowers—all this I remembered in a general way; but I had no idea of color. This card (3 B) fits in with everything I remembered from the first exposure. Therefore it is the same.

J ±: It seems to me that the child I saw there before held red flowers in her hands, now she has on a red dress. I had the idea "red" associated with the child, but I do not know whether I substituted "flowers" or "dress" or what. Therefore, I am only 50% sure of a change.

That the function of the image in recognition is only secondary, is manifested by the fact that the subject himself often refuses to rely on it, because he has learned by introspection that it is constantly changing during the interval. Thus one observer says:

"I feel more certain of those recognitions which I make on the basis of the feeling of familiarity than of those which result from a comparison of the image with the impression.

This, I think, is due to the fact that the images tend to become confused in my mind. Also they cause the attention to fluctuate and this fluctuation mixes up the details."

Another observer declares on the same occasion: "This flower-pot, (in B), looks a little larger than the one I saw before, (in A). But I do not know whether it really is larger or not. It may be an illusion because I know that sometimes my images grow during the interval and take on new features."

Thus to rely on mental imagery is not altogether a safe road to correct recognition. Nevertheless, the sight of the variable card would frequently call up the image of the normal, and then it was that the difference between the two—between the impression and the image—would fortify the judgment of recognition. But as this would happen only with a few subjects, it shows once more that the process of recognition is not wholly a comparison of two mental contents.

Compare these cases:

F: When I first saw V there was a sense of hesitation. Then the image of N came; I compared the present perception with the image and at once recognized the difference. All doubt vanished.

D: In this case the sight of V called up the image of N, I compared the two mental states and saw that they were different. But I get no difference of feeling on seeing a card of which I had an image and one of which I had none. The primary feeling of familiarity is the same. When, however, I see a card of which I had no image and the image "pops" up suddenly, then I become more certain of my judgment.

There were several states of affairs with regard to imagery: Either all the cards from the first exposure were carried in distinct verbal images; or all the images were distinctly visual with no verbal supplementation; or again, some of them were distinct and others vague; or all of them vague; or they formed a composite image; or else a few verbal images—such as a word or two from each card, were carried; or finally, no images were carried at all.

Some cards were more easily recognized than others—though

of the same degree of similarity—because they were distinctive or individualistic. That is, they were reproductions of famous paintings, or portraits, or of things that were especially familiar to some of the observers. The reason why these cards were easy to recognize is that they made a strong and unique impression on the first exposure. Where such individualistic cards cannot be obtained in sufficient numbers to make up the setting as well as the critical ones, they should be left out of the experiment altogether.

Objective Factors that Determine Recognition

A change of position, as left and right, up and down, was the most easily recognizable factor. But recognizability here depended on the ratio of the area of the transferred item to the total area of the picture post-card. The average size of a picture post-card is 5.5 x 3.5 inches. Hence, if a figure, whose area is 2 x 2 is transferred from one end to the other lengthwise, it will be recognized more readily than if transferred from one side to the other, i.e. breadthwise.

Next to change of position change of direction was most easily recognizable, especially if the pictures were those of human beings. And here recognizability was directly proportionate to the number of degrees through which the variable figure—face or body—was turned. A turn of 45° was less noticeable than one of 90° and that less than one of 180°.[10]

Of colors, red seemed to make the strongest impression, i.e. the replacement of one red figure by another, slightly different, was easier to detect than the displacement of a blue one by another or a pink one by another, other things being equal. An interesting fact was the following: I was fortunate to obtain two pairs of cards, A-B and C-D, which differed as follows: The central figure in A-B was a girl's head wearing a blue bonnet against a gold background; in A the face was turned to the left, in B to the right. The central figure in C-D was the *same* girl's head wearing a red bonnet, of exactly

[10] In this connection see, Dearborn, G. V. N., Recognition Under Objective Reversal, *Psych. Rev.*, Vol. VI.

the same pattern as in A-B, also against a gold background. And in C the face was turned to the left, in D to the right. This, then, was all the difference that existed between the two pairs of cards—namely, in the color of the hats. My first surprise came when I noticed that the 15 judges gave the first pair a higher rating in similarity than to the second pair. The ratio was 9:8. My second surprise came when I noticed that the laboratory subjects were less able to detect the difference between A-B than between C-D. Here, then, we had objects that were identical in form and content, differing only in color; and the red color helped discrimination more readily than the blue. It may be, however, that the red color formed a stronger contrast to the rest of the card than the blue, and for that reason the position of the face—the critical part of the card—made a deeper impression in the one pair than in the other.

Human beings are more distinguishable in various attitudes than animals, other things being equal; and the sharper the features of the human beings the deeper the impressions they make. In general, animate objects are more distiguishable than inanimate. This shows that recognition is not dependent so much on mere sense perception and memory as upon the revival of mood and attitude. Else why should it be more difficult to notice that a house formerly turned to the right is now turned to the left than it is to notice the same kind of change with a human figure? Introspection shows that new states of consciousness, new attitudes were aroused by the latter but not by the former. Thus, if a girl's face is turned to the side in one instance and to the front in another, the observer would make some such comment as this: "The first girl did not produce the same feeling that I now have. She seems to be coquetting with me; at first she turns her shoulder to me, and now she stares me straight in the face." Or, "she had a more delicate appearance before than now," and so on.

Errors of Recognition

Owing to their complexity the cards did not afford as good means for the analysis of the errors of recognition as did the

words. We could not, for example, tell with exactness whether the error was due to an incomplete perception of the variable—an error of "is", or to the obliteration of the normal—an error of "was."[11] By far the majority of the cases point to the latter, which simply means that the sensory-motor force was, or rather is stronger than the ideo-motor force.

In general, the mistakes of recognition were directly due to the degree of similarity; and that means that the elements which the observers fixed upon for discrimination were found in sufficient proportion in the variable card to make this latter acceptable for the normal. This is the fundamental fact of our entire investigation. It receives further proof from an examination of the definite errors themselves, i.e. discarding the doubtful judgments and payng attention to the wrong ones only—those marked (—) in our tables—we find that the ratio of these to the total judgments increases concomitantly with each degree of similarity. The following table shows this.

TABLE 34

Per cent of Absolutely Wrong Judgments

% S = ...	0	25	35	45	55	65	75	85	100
% (—) = ...	2	7	12	15	21	34	53	78	2

This fact stands forth regardless of any other elements that may enter in. The reason is that these other elements, disturbing factors, or whatever they may be, would distribute themselves equally over the entire similarity scale, and thus leave the influence of each degree as compared with every other one unhampered.

The disturbing influences mentioned by the observers were so much analogous to those that tentalize the human mind in daily life that we were well pleased to find them operating in our investigation, for, it should be remembered, that we were investigating the recognitive process under conditions comparable to those of daily life.

Thus it would sometimes happen that a card of the milieu would be more attractive than the critical one, with the result

[11] See pp. 50-54.

that the observer would have his attention absorbed by the former and get only a vague impression of the latter. If he then mistook V for N or felt uncertain whether or not he had seen V before, he had no one to blame but himself. His instructions were to distribute his attention equally, and if he could not do so in the instance just cited, he would very probably still less be able to do so in real life under similar conditions.

Again, the variable card would occasionally be mistaken for the normal because it resembled it in general appearance,—it told the same story. Such cards were disliked by the observers because they had no distinctive features. They had meaning, to be sure, but they meant too much the same thing. Such was the complaint. But here again we have a condition that is duplicated in real life. Do not all infants, for example, look very much alike? Yet they are different. To the uninitiated American all Asiatics look alike, but they are really as distinct from one another as Americans are.

A fourth source of error was that of over-confidence. Some cards would appear to be easy to grasp, the subject would feel that they could not be displaced without his recognizing the change; and so he would only take a glance at them. But here again he was mistaken in his calculations, as most of us are when in a similar frame of mind. Very often such a card would be displaced and the observer would fail to recognize the change.

The final source of error resulted from the impression of familiarity produced by the whole setting. "I have a feeling of familiarity for the group as a whole, and therefore I don't think any were changed," was a remark frequently made. This led me to investigate the influence of the environment on recognition with cards as I did with words. To that we shall now turn.

EXPERIMENTS E

The Influence of Environment on Recognition

The problem concerning the influence of environment on recognition has already been stated. It is this:

Will an object be more readily identified if seen in the same setting in which it was originally experienced than if observed in a new setting? Or in other words, does the feeling of familiarity or strangeness, as the case may be, which is aroused by the general environment color consciousness to such a degree as to make a new element appear familiar in the one case and an old element appear new in the other; or is the action one of contrast rather than fusion? If it is contrast, then the exposure of an identical element in a new environment should yield more correct recognitions than its exposure in the old environment. If it is fusion, then the percentage of correct recognitions should be lower for identical objects re-exposed in a new setting. That is, the feeling of newness, being heightened, should swamp the sense of identity and intensify that of dissimilarity.

Two methods for investigating this problem suggested themselves: either we could employ the same observers as in the previous experiments and new material, or new subjects and the same material. Since the results of this set of experiments were to be compared with those of the previous sets, we were anxious to keep the critical conditions as uniform as possible. It was deemed best to use the same material and different subjects.

Hence the series I made use of in this case were Nos. I, II, IV, and IX, whereby I exposed 4 cards for 10 seconds, 5 cards for 10 seconds, 4 cards for 7 seconds and 5 cards for 5 seconds. The method was as follows: The standard card, A was shown in the setting within which it had been exposed in the previous sets of experiments; then, after an interval of 20 seconds the variable card, B, was exposed in a totally different milieu but occupying the same position. The similarity between A and B varied from 0 to 100%. In the case of 0% S, the second exposure would contain nothing whatever that bore the slightest resemblance to anything in the first exposure.

The same apparatus was used. My observers were the same ones who participated in the word experiment.[12] They were already somewhat adjusted to the tests, but to make more sure,

[12] See p. 34.

they were given a week's practice. They came to me once a week, each at an appointed hour and day.

The instructions given to them were practically the same as those reproduced on page 35; only here they were told that on the second exposure there would exist one of three possibilities; either all the cards would be totally different from those of the first exposure, or one of them would be similar or identical to one in the first exposure.

I began with Series I—4 cards exposed for 10 seconds—and after that I turned to Series II. The next two series were exposed together. Obviously I was doing an injury to my theory which says that recognitive ability varies inversely as length of series and directly as length of exposure, for I was introducing the element of practice-improvement into the very series where I expected the theory to be substantiated, by putting them off to the last. But it seems to me that this is the only scientific way of procedure. For if I obtain low results with the shorter exposure-time, as I should, then they would have all the more value, for it would indicate that despite practice-improvement, the subjects are less able to recognize a substitution in a 5-second exposure than in a 7-second one.

The results of this set of experiments are given in the following tables.

Comparative Per Cent Correct Recognition when Variable Card (B) is Shown in New and Old Environment (N.E. and O.E.) Respectively.

TABLE 35

Series I: 4 Cards Exposed 10 Sec.

	% C				
% S	N.E.	O.E.	(N—O) E	No. Judgments	% P.K.
0	100	100	0	12	
35	100	90	10	4	100
46	100	87	13	12	91
56	100	82	18	12	100
65	92	78	14	12	100
74	94	67	27	20	90
91	25	10	15	4	?
100	81	97	—16	24	

TABLE 36

Series II: 5 Cards Exposed 10 Sec.

% S	% C N.E.	% C O.E.	(N — O) E	No. Judgments	% P.K.
0	100	100	0	12	
25	100	100	0	8	100
46	100	78	22	12	70
50	88	76	12	8	66
64	69	65	4	8	85
74	69	54	15	8	50
100	87	96	—9	12	

TABLE 37

Series IV: 4 Cards Exposed 7 Sec.

% S	% C N.E.	% C O.E.	(N — O) E	No. Judgments	% P.K.
0	100	100	0	8	
23	100	90	10	12	100
32	100	90	10	8	40
44	92	85	7	12	70
54	92	78	14	12	85
65	87	65	22	20	95
72	62	63	—1	12	100
88	56	20	36	8	
100	70	97	—27	38	

TABLE 38

Series IX: 5 Cards Exposed 5 Sec.

% S	% C N.E.	% C O.E.	(N — O) E	No. Judgments	% P.K.
0	100	100	0	12	
23	100	79	21	12	60
34	100	74	26	12	66
45	95	67	28	11	40
55	88	61	27	12	60
64	73	35	38	15	40
73	75	40	35	12	66
85	50	20	30	8	
100	54	91	—37	47	

At first sight it would appear that these tables present contradictory results. For we notice that those cards whose value is less than 100% S are discriminated *more* often in the new setting than in the old, whereas the cards of 100% S are identified *less* often in the new environment than in the old. According to the first fact it would seem that the new milieu sharpens the faculty of discrimination; according to the second, it dulls

that of identification. But that is not so. Instead of being contradictory the results are supplementary.

The first important fact that stands out before us is this, namely, it is more difficult to identify the same thing in a new environment than in the old. The falling off in recognitive ability is 16, 9, 27 and 37 per cent respectively in each of the four series employed. Hence it follows that the feelings of familiarity and strangeness do not enhance each other by contrast. For suppose they did. Then not only ought more identifications to be made in the new milieu when an identical item is repeated, but more items whose similarity is greater than 50% ought to be falsely recognized in the new setting than in the old. The reason is that in proportion as the similarity increases it should be enhanced by the surrounding field of newness and thus precipitate the judgment of "the same." But just the opposite is true; cards whose similarity varies between 50 and 100% S are less often mistaken for each other in the new environment than in the old.

There are, therefore, only two possible ways of accounting for this phenomenon. (1) Either the mass of new material, flooding consciousness, obliterates all memory of past perceptions and thus precipitates indiscriminately the judgment "new," whether anything is new or not; or (2) the feeling of strangeness produced by the new environment predisposes the mind to judgments of difference on the principle of suggestibility, said predisposition varying drectly as the mass of the new field and inversely as the intensity of the repeated item.

The first theory seems to find substantiation in the fact that the per cent perfect knowledge (% P. K.) is smaller when the environment is new than when it is old. That is to say, after seeing the variable card in the new setting and rating their judgments of change at a 100% certainty, the subjects were not able to state what the corresponding normal was as often as when they saw the same variable in the old setting. The only explanation for this is that the perception of a mass of new material obliterates the memory of the old—just as we saw that a variable of 0% S will wipe out all traces of its mate.

If this were the correct explanation, however, then there is no reason why C should vary inversely as S when the environment is new as well as when it is repeated. For the new field that surrounds a card of 72% S, let us say, is just as large for any given series, as that which surrounds a card of 35% S, therefore obliteration in one case ought to be as complete as in the other. Hence if C depended on obliteration alone it ought to have the same value in both cases.

But it has not the same value for all degrees of S. On the contrary, C varies in a uniform manner inversely as S. Moreover, it varies as E (environment). Therefore, other things being equal, we are justified in saying that C is a function of two variables: S and E. But are we not plunging into a difficulty here? It is our desire to establish a definite relation between C and S alone, and heretofore we have treated these factors conjointly as if no third one existed; and now when S appears in a new environment we are trying to say that the environment functions also. Admitting that N. E. tends to inhibit identification by predisposing the mind to say "change"; does not O.E. tend to inhibit discrimination in a similar manner by predisposing the mind to say "the same?" If so, then all the relations that we have thus far established between C and S are invalid because the old environment (O.E.) functioned all the time.

To allay these misgivings it is only necessary to say that this factor (O.E.) has already been taken care of by the first part of our Correction Formula. (100-S) $Y = K'$. That is to say, the extent to which the old environment has a tendency to precipitate the judgment of "the same," or to inhibit discrimination between two unlike things is directly proportionate to the number of false judgments made for 0% S substitutions in O.E., and this value if 2%, (Table 34). Therefore, O.E. = .02, or it is almost negligible.

Every time we made use of the correction Formula we took into account the influence of O.E. Hence we are justified also in trying to determine the value of N.E. Now it happens that the per cent of errors made when 0% S is substituted in

O.E. is much less than when 100% S is substituted in N.E. Does that mean that two totally dissimilar cards are much more unlike than two identical cards are identical? Such a thing is possible, i.e. two dissimlar cards may have not zero similarity but minus zero similarity, whereas two identical cards can never have more than absolute identity. I do not think, however, that this argument affects the results. Because in so far as I selected my material from the same universe of discourse—picture post-cards—my fifteen judges had a right to rate all cards that had no resemblance in them at 0% S. Therefore, since the old environment did not cause as many mistakes to be made with 0% S substitutions or even with 35% S substitutions as the new environment causes with substitutions of 100% S, we are justified in concluding that O.E. has not as great a tendency to predispose the mind to judgments of "the same" as N.E. has to predispose the mind to judgments of "different."

What is the value of N.E? To determine that we simply have to note the extent to which it causes the identical item to escape detection minus the amount of the same kind of error which occurs in O.E. This difference, as given by the four preceding tables is 16%, 9%, 27% and 37%, the average of which is 24%. Therefore, N. E. = .24. That is to say, the tendency of a new environment to cause an identical thing to escape detection is 12 times as strong as is the tendency of a repeated setting to cause a totally dissimilar thing to be falsely recognized. Hence it appears that the feelings of familiarity and strangeness tend to neutralize each other by fusion, that one giving the central tendency to thought which is induced by the strongest stimulus.

This is not all, however. The fundamental problem that confronts us at this point is to find the relative values of O.E. and N. E. with respect to the identification of cards of 100% S. This is the only way we can establish an independent relation between C and S.

In the four series under consideration an average of 5 per cent error occurred when all 5 identical cards were repeated,

but it rose to an average of 27 per cent when only 1 card was repeated in a setting of 4 new ones.[13] The probable per cent of error that fell to the lot of any one particular card in the former case is 5% x ⅕ = 1%. Subtracting this from the latter result in order to neutralize the precipitent tendency to say "change," leaves 26% as the amount of error due directly to the influence of N. E. Therefore, under the conditions of our experiment, the probability that a thing will be recognized when seen in the same environment is $\frac{99}{100}$, whereas the probability that it will be recognized when observed in a new setting is only $\frac{74}{100}$.

These figures harmonize so well with those obtained in the experiment with words that they must stand for fact and nothing else.[14]

And now let us see if we can account for the fact that discrimination appears to be easier in the new setting than in the old.

The figures given in the second horizontal line of the summary table, (page 109), represents the judgments of "change" or "all new." Now, as a matter of fact, *all* cards were changed objectively in every instance except where S = 100%. And though the observers were able to point out the similar card in the new environment, they were not able to state in more than 75 per cent of the cases how it differed from its analogue. Therefore, inasmuch as the new setting caused the subjects to declare in 27 per cent of the cases that all cards were new when one identical card was repeated, it must also have caused them to make the same kind of a judgment when a card of less than 100% S was substituted irrespective of whether they perceived the difference between this card and its analogue or not. Only we must not assume that the tendency was just as great with each diminishing degree of similarity. For certainly when a card of 65% S is substituted the amount of difference within it would have a tendency of its own to elicit the judg-

[13] Actually two of the four series were exposed in groups of 4 and two in groups of 5.

[14] See p. 46.

ment "change," and likewise when a card of only 25% S is substituted it would have a still greater tendency of its own to elicit a judgment of difference. And so in general we may say that in proportion as S recedes from 100% in that proportion does the influence of the environment proper diminish. This is the fundamental principle upon which the correction formula was constructed. It was explained, (pp. 36-39) that, inasmuch as there seems to be a simple inverse relation between recognitive ability and degree of similarity, the tendency of the setting to precipitate a judgment of identity with respect to a thing that is different is (100-S)Y, which value should be added to the % C corresponding to the S in the expression; whereas the tendency to say "change" when no change exists is SX. $\frac{A}{B}$, which value should be subtracted from % C.

Now this latter is the factor that has to be employed in the present case, inasmuch as the only apparent error is that made with respect to identical cards. Only here A/B = 1 because only one card was repeated, i.e. the error of 27% was made with respect to one card. If now we multiply each value of C in N. E. by the formula 0.27 x S, (since X = .27), and subtract the product from the original value, we shall obtain almost exactly the same values that C possesses in O. E. Thus we derive an independent relation between C and S, and incidentally prove that the old environment does not tend to produce false recognitions to the same extent that the new environment tends to produce false discriminations.

The following table contains the corrected results for recognition in the new as compared with the repeated setting.[15]

TABLE 39

Comparative Per Cent Correct Recognition when Cards of the Same Degree of Similarity were Substituted in New and Old Environments.

% S	0	25	35	45	55	65	75	85	100
% C in N.E.	100	93	91	83	77	62	55	21	72
% C in O.E.	98	90	85	79	74	61	56	17	99
% C (N — O) E.	2	3	6	4	3	1	—1	4	—27

[15] For the practical application of these results, see article by the author on The Influence of Environment on the Identification of Persons and Things, Jour. of Criminal Law and Criminology, Vol. V., No. 1.

The different values of C corresponding to the same % S are so close to each other that they prove conclusively that the corrected relations established between C and S in O. E. are independent of the setting. The average difference between % C in N. E. and % C in O.E. for values of S that are greater than O and less than 100% is 3. This may be interpreted as meaning either that N. E. facilitates discrimination to that extent or that O.E. inhibits discrimination by that much. But since we find directly that the average per cent of false recognitions due to O.E. is 2 per cent when substitutions of 0% S are made, it would seem that the latter interpretation is the correct one.

I must caution the reader once more not to assume that the difference in ability to recognize an identical item in the two sorts of environments is due to retardation of perception occasioned by the new setting. No such retardation occurs. Introspection shows univocally that the new surrounding is recognized as new instantly; that the cards which compose it receive the barest glance and are immediately dismissed from consciousness.[16] Hence more time, if anything, is afforded to the observer to dwell on the critical card and to determine whether it is only similar to or identical with something he had seen in the first exposure.

Thus one subject says: "When all cards but one are changed, I readily eliminate the new ones and spend more time on analysing the repeated or similar one. Whereas if all cards but one are the same, I have to study each one before I can determine whether it is identical in all respects with what I saw in its place before."

And again: "The cards constituting the environment do not give me any shock. The more different they are from those I saw in the first exposure, the less effect do they have on me. I 'slide' right over them before they rise to the center of consciousness. But the more similar a card is to one previously seen the more does it disturb me. I have to look at it until I fully determine whether it is new or not."

[16] See also Katzaroff, *op. cit.*, p. 57.

Yet it must be acknowledged that not all observers were able to say definitely whether the new setting did in itself produce the feeling of strangeness. It would seem that the acknowledgment of such a state would be necessary in order to substantiate the theory of fusion. With some observers a decided consciousness of the feeling of strangeness comes only when they see a similar card. Thus subject B declares on one occasion, "There was an immediate feeling of strangeness produced by the variable card, but not by the others. I recognized them as new instantly. It is only when I am doubtful that the feeling of strangeness or familiarity makes itself felt." Nevertheless, we may conclude that inability to recognize an identical object in a new environment is due to the suggestible influence of newness or strangeness arising from such environment.

So much for the results that pertain to the material. Let us now turn to those that concern the observers.

Individual Differences

When we come to examine individual differences we find that they are larger in the methods or devices employed in recognition than in the actual results themselves. Some observers thought they did best when they actively clung to their images during the interval—they are C. G and J. Others felt that the mere endeavor to retain the images produced mental confusion, so they remained passive during the interval—they are A. B. F and I. Again, some tried to select an essential element from each card and use it as an earmark—they are D, G, A; while others merely tried to get a general impression of the entire card—they were B, F, I, H and J. Some would go over all the cards rapidly, thus getting several hasty impressions from each; others would first obtain a general impression from the whole group then scrutinize each card carefully; others still would first examine each card carefully and then, if there was any time left, get a general impression of the entire group.

When we examine our subjects with respect to their accomplishments, we find that they fall into three general classes.

(1) Those that are determined in their judgments—not given to much doubt. They are above the average in accuracy, but no better than the average in inaccuracy. (2) Those who are subject to doubt and hesitation—their errors are below the average while their accuracy is the same as that of the former group. (3) Finally, those whose accuracy is below the average, whereas their doubt and inaccuracy are above the average. The following table contains the per cent of accurate (+), doubtful (±) and false (—) recognitions made by each of the ten observers who participated in Experiments A to D inclusive.

TABLE 40

Per Cent Distribution of Judgments.

	1			2				3				
Sub-jects=	D	E	C	A	G	B	F	J	H	I	Av.	M.V.
+ =	64	64	60	61	63	64	64	53	42	45	*58*	6.8
± =	12	10	11	15	15	18	18	22	21	11	*15*	3.5
— =	24	26	29	24	22	18	18	25	37	44	*27*	6.1

That two of the observers, H and I, vary so much from the others is to be accounted for by racial differences and early training. Though not of the same race, their early bringing-up was such as to render them unacquainted with the sentiments and ideas expressed in many picture post-cards. Such cards, therefore, did not have the same meaning to them—hence not the same apperceptive values—as to the other eight observers who were all Americans.

It is significant that the average per cent correct recognition which I obtained, 58%, is remarkably close to what Katzaroff got with totally different material and by a different method of experimentation. His value was 50%.[17] This is lower than my average, but that is probably because his material was less meaningful, and Hollingworth has shown that the recognition of an object varies directly as its meaning.[18]

There appear to be no differences due to sex.

[17] *Op. cit.*, p. 34.
[18] *Op. cit.*

Conclusions

If we bring our main results together we arrive at the following conclusions:

(1) Recognitive ability varies inversely as degree of similarity.

(2) When objects of approximately the same complexity as ordinary picture post-cards are exposed in groups varying between 3 and 6 at the rate of 1 per second, the inverse relation between recognitive ability and degree of similarity, expressed in percentage, is as x: (100-x).

(3) The same relation holds for words of two or three syllables exposed in groups varying between 6 and 8 at the rate of 1 per ½ sec.

(4) With such objects as picture post-cards the relation between the number of objects exposed and length of exposure, in terms of seconds, is as $1:(1+\frac{1}{2}-x)$, where $x<\frac{2}{3}$ seconds.

(5) The objects must reach at least 25 per cent similarity before they can have a confusing effect on the process of recognition.

(6) The process of recognition is affective and is independent of cognition.

(7) The feelings of familiarity and strangeness inhibit each other by fusion.

(8) It is more difficult to recognize an identical object in a totally different setting from the one in which it was originally seen than in the same setting, the ratio of difficulty being about as 27: 1.

(9) It is more difficult to recognize an identical item in a new setting than a totally different item in the setting previously experienced, the ratio of difficulty being about as 12 : 1.

(10) Recognitive ability varies inversely as the number of objects perceived—time being constant.

(11) Recognitive ability varies inversely as the number of objects exposed—time being proportionate and not more than one second per object.

(12) Recognitive ability varies directly as the temporal length of perception.

(13) Some of the errors of recognition are due to the incomplete perception of the object when first experienced.

(14) Some cases of false recognition are due to the incomplete perception of the mistaken object, owing to the superiority of the ideo-motor force over the sensory-motor force.

(15) But most cases of false recognition are due to the obliteration from memory of the original impression by the present perception, and this is due to the superiority of the sensory-motor force over the ideo-motor force.

PART IV

The Application of the Laws of Recognition

As a result of our investigation we have come to the conclusion that two such words as "Camphenol" and "Camphenyl" for example, which stand for two absolutely different proprietory medicines, have a psychophysical similarity of 80 per cent. We found that such similarity will produce approximately 80 per cent confusion in discrimination as compared with the ability to discriminate words of less than 20% S and to recognize words of 100% S. It is hardly necessary for us to state under what conditions this holds true. It should be understood, once and for all, that we mean under conditions comparable to those that obtain in daily life. When the chemist says that ammonium hydroxide will precipitate iron, it is understood that he means under ordinary temperature and pressure and out of a neutral solution. So here, too. After careful investigation we have found, for instance, that words which have a certain number of symmetrically arranged letters in common possess thereby a definite amount of similarity. It has been found that it is most convenient to measure this similarity in terms of the mathematical ratio that the number of commonly possessed, symmetrically arranged letters bear to the total number of letters.

Finally, it has been found that similarity and discrimination stand in the same relation as the reciprocals of their per cent.

Let us now see how these facts can help us in the solution of a practical problem.

As I write these lines I have before me the abstract of a report delivered in 1911 by C. A. Mayo, Esq., before the American Pharmaceutical Association on Pharmaceutical Nomenclature. Referring to the confusion which frequently arises with disastrous results from the similarity of drug names, he says:

In Richmond, Va. . . . a death occurred from the dispensing of "lysol" instead of "laxol." In Connecticut damages were

recovered from a druggist who sold "calomel" when "columba" was ordered. In Germany a fatal accident was reported in 1908 from dispensing a solution of "chlorinated lime" when "calum chloride" was called for, and in Russia a child was killed through dispensing "saccharin" when "saccharum" was ordered. "The occurrence of these cases which have reached the public notice," says the author, "indicates the probability that many such incidents occur which never become public. *That such incidents do occur with increasing frequency is a matter of common knowledge among druggists everywhere.*"[1]

The report contains a rich list of names of high similarity, representing different proprietory medicines, drugs and chemicals. We select only a few for illustrative purposes.

(1) Acetin	(6) Analgesin	(11) Benzine	(16) Cerebine
(2) Aceton	(7) Analgine	(12) Benzene	(17) Cerebene
(3) Acetone	(8) Apinol	(13) Benzoin	(18) Cerberin
(4) Alcotine	(9) Apetol	(14) Camphen	(19) Cerberine
(5) Alcotone	(10) Apicol	(15) Camohene	

This is enough. Now what confusion is apt to arise from such a babel of names as these? Let no one say that the results of our investigation cannot be applied to the above case, because druggists, being supposed to have a first rate acquaintance with such names as the foregoing, would not be confused half as often as the layman may think. To such argument we reply that we were aware of this fact only too well, and for that reason we did not use technical or difficult words on our subjects, but on the contrary, words that were as familiar to them as the above names are to the average druggist.

Nor should it be assumed that because the druggist knows the danger which is apt to result from confusing one name with another, he will therefore be more careful and will make less mistakes than one would infer from my tables. To this argument we need only answer that it is as criminal to tax the mind with unnecessary burdens as the body. The fact that the engineer knows his train will be wrecked if he runs past a danger signal, will not help him to see that signal if it is ill-ar-

[1] Italics my own.

ranged or if he is color blind. But the cases cited by Mr. Mayo, himself a member of the drug profession, constitute a sufficient answer to such objections. If we examine the mathematical similarity of several of the above named words, we find that they possess the following values: (1-2) = 80% S, (2-3) = 85% S, (4-5) = 87% S, (18-19) = 94% S. The probable mistakes in recognition that would result from these words among druggists, i.e. persons acquainted with them, are: 80, 85, 87 and 94 per cent respectively.

Now, it is either for the drug profession or for the law maker to decide what constitutes a dangerous degree of similarity. We have determined how the various degrees operate, just as the dietician ascertains the effects of various food preservatives on the tissue. Personally, I am convinced that objects of more than 60 per cent similarity cannot be discriminated with sufficient ease by the average person, exercising the usual amount of care which we can reasonably expect him to exercise, under the conditions of normal life. This value, or any other which the law makers happen to decide upon, may be too high for some persons and too low for others. The former will claim that it fails to protect them, the latter that it is too arbitrary. But this is the complaint heard about every law—from the national tariff to the speed ordinance of the smallest New England village.

The present investigations indicate that objects of 60 per cent or more similarity will be mistaken for one another at least 50 per cent of the times out of every ten observations. Suppose, then, that we have words, or names, or trade marks, or what not, the similarity of which we wish to discover? The simplest method is to expose one of these items among others of the same category, for such time and under such conditions as the skilled psychologist shall suggest. This exposure should be made to ten or twelve persons of normal eye-sight, and then it should be noted how many of them discover the substitution when the first item is replaced by the second. My own suggestion is that one of the formulas N_4-t_4, N_5-t_5, N_6-t_7 should be used with items of some complexity, and that N_8-t_4 with words or names.

What is the advantage of such a method? it will be asked.

Is it not the height of absurdity first to build up a scale of similarity by subjective judgments, then to establish a relation between recognition and these judgments, and finally to turn round and declare that subjective judgments of similarity are valueless—only the actual discrimination judgments are indicative of the similarity of the objects? If the comparison judgments of 15 college men are good enough to determine the similarity between two objects, in the construction of the similarity scale, then those of 12 jurymen are equally reliable in suits involving trademark infringment, and there is no reason why the court should burden itself with psychologists and psychological paraphernalia.

Moreover, the mean variations among the psychological judgments are smaller than those of the discrimination judgments, hence the former must be more objective, i.e. more representative of the actual similarity of the objects, than the latter.

I have purposely given this argument at some length in order that we may the more tenaciously cling to the truth when we have arrived at it. How shall we answer this hypothetical challenge? The task is not difficult.

It is the utmost desire of all court proceedings to render a verdict solely based on the evidence of facts—a verdict the justness of which is not open to doubt. But in civil suits involving illegal imitation the presentaton of unimpeachable facts is next to impossible.

Infringment of trademarks exists, according to the British Lord Ordinary's definition, "when they are liable to be mistaken by ordinary purchasers, not applying their minds closely to the matter, for the trademark of the goods of the trader who is the proprietor of the mark."[2] This definition has been closely adhered to by some courts and the unwary purchaser protected. But not so in all cases. As the New York Times has remarked editorially, "Usually when a case comes to trial, the trademarks in question are brought together for comparison by the judge and jury, who are thus accorded a privilege denied the unwary purchaser, and the comparison is aided and

[2] Rogers, *op. cit.*

emphasized by able counsel. In every way and by suggestion the difference between the two marks is accentuated, and, perhaps unconsciously, the learned judge projects his enlightened mind upon that unwary purchaser, until he endows him with his own sagacity and wisdom." To be sure, the testimony of persons who have actually been misled by the imitation is valuable, but unfortunately "the courts too often set them down as extraordinarily careless or foolish persons, devoid of common sense in comparison with the unwary purchaser of legal fiction."

And so we might say that by the time a decision is rendered, that which originally was a matter of fact, has ultimately become a matter of suggestion, of theory and cogitation, so that neither judge nor jury are in a position to decide with any degree of certainty whether two things are or are not similar enough to constitute an illegal imitation. This is evidenced by the large number of diametrically opposite decisions which have been handed down in almost identical cases of trademark infringement. We shall cite only a few.[3]

(1) In the case of the Sterling Remedy Co. v. Spermine Medical Co., in the Circuit Court of Appeals in the Seventh Circuit, 112 Fed. R., 100, there was involved among other things, the right of the complainant to enjoin the unnecessary imitation of the hexagonal form of the Cascaret tablet. It was contended that complainant's product was to some extent identified by the form of the tablet and the defendant's imitation of this form was unnecessary. The court rendered a verdict for the complainant.

(2) Globe Co. v. Brown, 121, Fed., 90; the imitation of the *form* of a letter file was enjoined.

(3) Yale and Towne v. Adler, 154, Fed., 37; the unnecessary imitation of the form of a padlock was enjoined.

(4) Wrigley v. Larson, 195, Fed., 568; an imitation of Wrigley's Spearmint Gum Package was enjoined.

"There are many other cases from which jurists might safely

[3] For the cases herein cited I am indebted to Mr. G. M. Besett, Chairman of the Committee of Trademarks for the National Wholesale Druggists Association.

conclude that the unnecessary imitation of a non-functional part of a machine or piece of merchandise was unfair competition and enjoinable," we are told. But let us see how the same matter was treated on other occasions.

(5) Pope Automatic Merchandising Co. v. McCrumb-Howell Co., 191, Fed., 979; the Circuit of Appeals of the Seventh Circuit refused to enjoin the defendant from imitating the physical appearance of a hand vacuum cleaner.

(6) Mississippi Wire Glass Co. v. Continuous Glass Press Co., 81 Atl., 374; Vice Chancellor Stevens, of New Jersey held that the complainant could not claim a right in a hexagonal shape of mesh for wire setting inserted in a fire retardant glass, although it was established by a reasonable amount of testimony that complainant's product was identified by means of the appearance contributed by the shape of the mesh. [Compare this with case 1.]

(7) Rathbone, Lord & Co., v. Champion Steel Range Co., 189, Fed., 26; the Court held that so far as concerned the ornamental dress of a stove, the defendant was free to copy. [Compare this with conclusions of cases 1, 2 and 3.]

(8) Edward Hilker Mop Co., v. United States Mop Co., 191 Fed., 613; it was held that the defendant could not be enjoined from imitating the visual appearance of the complainant's mop. [Compare this with case 2 and 3.]

These cases, representative of scores that could be cited, will suffice to show how absolutely impossible it is to decide by present day methods, how much similarity does or does not constitute unfair imitation. Obviously these diverse decisions could not have been rendered on the evidence of facts, because facts are incapable of opposite interpretation.

Now this method of ascertaining the legitimate or illegitimate similarity of two objects is outwardly equivalent to the subjective judgments rendered by our 15 individuals whereby the amount of similarity between pairs of picture post-cards was determined. I say outwardly because there the comparison ends. For the rest, the methods were totally dissimilar with the balance of favor on our side. The reason is this. In the court room

the opinions of judge and jury are swayed if not determined by the persuasive arguments of opposing attorney. Of course all items that are not absolutely identical have some distinctive features about them, and in so far as they are held up side by side, and clever arguments and suggestions are made by an array of able counsel, these features, however small, may loom up very large and vice versa. Under such circumstances a naïve, matter-of-fact sort of judgment can hardly be rendered. Yet that is the kind of judgment that is necessary in cases like these, because the faculties whereby we recognize and discriminate things in the physical world are primarily naïve. In short, recognition and discrimination are primary processes—they do not belong to the cognitive faculty, but are midway between cognition and affection. Therefore, it is fundamentally wrong to try to determine by logic and argumentation whether two things are or are not similar enough to cause confusion in perception, memory and feeling.

In so far, then, as we avoided all forms of suggestion by taking our 15 judges separately into the quiet laboratory, and allowed them to decide the similarity of the cards on the basis of "first impression," we think that their judgments were more representative of objective similarity than any court can reach.

Yet even this method is not wholly reliable. The process of comparison is not the same as that of recognition. In the former case you have the items directly before you. The impression of one can be superimposed on the image of the other; the items may be examined analytically or synthetically, i.e. the observer may fix his attention now on the parts that are identical and now on those that are different, or he may take in the total impression. Recognition involves no such processes as these. Hence, to try to determine recognitive ability by the comparison method is like trying to pass judgment on the quality of symphony by picking out its tones and over-tones by means of resonators.

In all matters of law the merits of the case alone must engage the attention of the court. In supposedly illegal imitation the point at issue is the similarity of impression made by two

objects separated in time and space. Therefore to bring those objects in close proximity to each other and to observe them at the same time, is entirely contrary to the issue involved. It is like attempting to ascertain the amount of adulteration in a food-stuff by its taste or appearance. Nothing but a psychological test on recognition can determine the amount of confusion that two objects possess for the average human consciousness. There is nothing derogatory in the application of scientific methods to court procedure.

The reason why a fair decision on illegal imitation can be reached only by resorting to such a psychological test as we have decided is that there we can determine with mathematical accuracy precisely the amount of confusion produced by the two things under consideration. The results rendered are not open to doubt. The experiment may be carried on either in the presence of the court or in the quiet laboratory of the psychologist. Let us present a concrete illustration.

Suppose it is such a case as that of the Crystalleid Water Co. v. Schultz, 2 Trademark, Rep. 251. Here the court held that there was no unfair competition in the use of a bottle similar in shape, containing a liquid similar in color to that used by another firm provided the label was distinctive. An opinion diametrically opposite to this was handed down in the United States Court of Appeals in the case of the Moxie Co. v. Daniel Daoust. The court's ruling was in part as follows: "Moxie is a well-known beverage put up in a bottle which is of a distinctive shape for many years associated with the beverage Moxie. The defendant makes a beverage quite similar in color and taste. This is put up in bottles, which in color and shape, closely resembles the Moxie bottle. The similarity of the beverages in color and taste together with the similarity of the bottles, facilitates the substitution of the defendant's beverage for Moxie without detection by the customer. There are points of difference in labels blown into glass and affixed thereto, in caps, etc., but they are differences which do not destroy the general similarity of appearance to the ordinary purchaser and therefore are of no consequences and need not be dwelt upon.

Both from our own inspection and from the evidence in the records we are satisfied that the resemblance is such as to mislead purchasers." The case was remanded to the district court with directions to enter a decree of injunction.

In both these cases such terms as "distinctive," "similarity in general appearance," "our own impression," etc., are used in a subjective sense. Hence the diverse decisions.

Why should the defendant in the suit of the Crystaleid Water Co. v. Schultz have been allowed to imitate the bottle of the plaintiff, and why should he have been enjoined in this latter case? In one or the other of these instances there has been a miscarriage of justice. The following method might have been used with more equitable results.

(a) The subjects on whom the experiment is to be performed are chosen on the basis of being representative of the average normal individual. (b) The court psychologist constructs his apparatus to meet the situation at hand, but in all instances he must see that it separates observer from experimenter. (c) He must then adjust his experimentation so as to find the ideal formula for the particular object in question. That is, if it happens to be the alleged imitation of a bottle, as in the above case, he must find that combination of the number of bottles (N) and time of exposure (t) which, with N having the highest and t the lowest values possible, two totally dissimilar bottles will be discriminated by the subjects 100 per cent of the times and two identical bottles will be identified 100 per cent of the times when one is replaced by the other at intervals of 20 or 30 seconds. (d) A totally different bottle would be one of different shape and color but approximately of the same volume, for surely the complainant cannot ask that the defendant be enjoined from selling his goods in any bulk he pleases. (e) The apparatus may be so constructed as to expose the items to the ten or twenty observers assembled and have them record their own results. (f) Or the experiment may be carried on with one observer at a time and have him dictate his results either to the court clerk or to the person conducting the investigation. (g) Three exposures should be made to each observer: (1)

One bottle—or whatever the item may be—should be displaced by a totally dissimilar one: This will test the subject's ability to recognize substitutions of zero similarity, (0% S). (2) Within a wholly new field but of the same complexity as in the previous case, the complainant's bottle or item should be exposed and then replaced by defendant's. (3) A totally new setting of the same complexity as in the previous cases should be exposed and nothing displaced on the trial exposure—this will test the observer's ability to identify the same item (100% S). (h) The observers addressed individually or together, according to how the experiment is conducted, should be given the following instructions: N objects (named) will be shown for t seconds, after which a period of p seconds will intervene. During this interval you must hold yourself ready for a second exposure; for at the end of the interval N objects of the same category (named) will be shown to you again for t seconds, and thereafter you must record in writing or dictate to the clerk whether the second exposure differed from the first in the presence of a new item or whether it was identical with the first. And if you think you see a new item (named) in the second exposure you must give its location in the group—or its number if they are numbered— and you must state what it has displaced and how it differs from the displaced object.

Thus we shall obtain a number of judgments in each of the three instances. Suppose there are twelve of them and that they are distributed in the following manner: First test: 11 subjects recognize the substitution definitely and 1 is in doubt. Second test: 3 observers recognize the substitutions positively, 4 are in doubt and 5 fail to recognize it completely. Third test: 10 identify the group as being the same positively, 1 doubts a single item, and 1 is sure that one of the items is new.

Calling the resemblance of the two totally unlike objects 0% S, of those that were not changed, i.e. in the third trial, 100% S, and of those whose similarity we are trying to determine x% S, we can arrange our results thus:

% S =	0	x	100
+ =	11	3	10
± =	1	4	1
— =		5	1
Therefore % C =	96	42	88

Now apparently either the conditions of the experiment were not ideal or some of the observers were not absolutely normal, else the 0% S substitution would not have been missed 4 per cent of the times nor would the observers have said that a substitution was made 12 per cent of the times when none occurred at all. As a result of the first error the defendants have a right to say: If the observers failed to discriminate the difference between two things of 0% S, 4 per cent of the times than at least that much ought to be subtracted from the amount of confusion produced by our item, or that much should be added to the % C (correct recognition) when our item was substituted. As a result of the second error the complainants might argue: Owing to the nature of the experiment or the idiosyncrasy of two observers there was a tendency of 12 per cent to say "change" when none was actually observed. The probable per cent of this tendency with reference to any one particular item in the group was 12. $\frac{1}{B}$, where B is the number of objects exposed in the group. Hence that much should be subtracted from % C with reference to x, as being due to the precipitant tendency of thought, under such conditions, to express itself in the judgment "change."

To settle these differences we apply our Correction Formula: (100-S)Y—SX. $\frac{A}{B} = \pm$ K. Let Y equal per cent error at 0% S end of scale and X equal per cent error at 100% S end of scale; then the amount of correction that should be made for x, the unknown amount of similarity, is (1.00-.58) x .04—.58 x .12 $\frac{1}{B}$ = K (since S varies inversely as % C when C = change, and since C in this case = 42%). Suppose B = 6, then K = .005. Adding this value to % C found with reference to x, yields 42.5%. Hence we say that a substitution of defendant's bottle for complainant's will be recognized as different 42.5 per cent of the times. And since the first law of recognition says that recognitive ability varies inversely as

degree of similarity, the court is justified in declaring, on the basis of the foregoing evidence, that defendant's merchandise, bottle or whatever it may be, is 57.5 per cent similar to the complainant's. If the law makers decide that in such cases as these 25% or 30% or 40% confusion is permissable, then the value found, being above the safe limit, constitutes an illegal imitation. From such judgment there can be no appeal. About the fairness and accuracy of such judgment there can be no doubt.

Needless to say such tests are possible only in the case of portable items. When the items are not portable, or cannot be manipulated with facility in such an experiment, their photographs should be used.

Note. Another kind of similarity that may be cause for litigation is not form but generic similarity. It is the kind of resemblance existing between two items whereby one of them is enabled to inveigle itself into acceptation by virtue of the favorable disposition created in the purchaser's mind by the other. The individual need not mistake one object for the other, he may be perfectly well able to note the difference between them, yet because they have this generic resemblance, he reasons from similarity of name to similarity of origin or quality. Thus there is generic resemblance between Hotel La Touraine and La Touraine Coffee. Knowing that the former is a high class hotel, I infer from the similarity of the names that La Touraine Coffee has some connection with the La Touraine Hotel. Perhaps it is used at that hotel, and if so it must be of an excellent brand.

There is generic resemblance between Royal Baking Powder Co. and Royal Bakery. By the principle of radiation, the sense of quality induced by the former spreads to the latter. Again, there is generic resemblance between Snappy Cheese and Nippy Cheese, though here of course, it being a question of the same item, it is sufficient to consider the form similarity of the names alone. Yet imitation exists even if the customer who is in the habit of buying Snappy Cheese knows perfectly well that Nippy Cheese is not Snappy Cheese when he is confronted with the proposition of buying the former for the first time. The imitation arise from the fact that he thinks that Nippy Cheese is about the same as Snappy Cheese, or he may think that it is a different brand of the same article manufactured by the same firm—because of the similarity of name.

Where generic resemblance alone exists between two things belonging to different categories, such as those cited in the first two illustrations, the psychologist cannot be of service to the court in a practical way.

BIBLIOGRAPHY

ALLEN, A. Recognition, Am. Jour. Psy. Vol. 7.

ANGELL, F. Discrimination of Shades of Gray for Dffierent Interval of Time, Philos, Stud. Vol. 19.

——— Judgments of Like in Discrimination. Am. Jour. Psy. Vol. 18.

BENTLEY, M. The Memory Image, Am. Jour. Psy. Vol. 11.

BERGSON, Matter and Memory.

——— La souvenir du present at la fausse reconnaisance, Rev. Philos, Vol. 33.

BETZ, Vorstellung und Einstellung: Über Wiedererkennen, Archiv. f. d. ges. Psych, Vol. 17.

BOURDON, B. Reconnaissance, Discrimination et Association, Rev. Philos. Vol. 40.

CLAPARÈDE, E. Recognition et Moiite, Archiv. de Psych, Vol. 11.

DEARBORN, G. V. N. Recognition Under Objective Reversal Psy. Rev. Vol. 6.

FISCHER, A. Versuche über Reproduction und Wiedererkennen, Zeitsch. f. Psych, Vols. 50 and 51.

GAMBLE AND CALKINS. Die Reproduzierten Vorstellung en beim Wiedererkennen, Zeitsch. f. Psych. Vol. 32.

——— Über die Bedeutung von Vorstellungen für die Unterscheidung von Qualitäten Sukzessiver Reize, Zeitsch. f. Psych. Vol. 33.

GEISSLER, Measurement of Attention, Am. Jour. Psy. Vol. 20.

HEINE, ROSA. Über Wiedererkennen und rückwirkende Hemmung, Zeitsch. f. Psych. Vol. 68.

HOLLINGWORTH, H. L. Some Characteristic-Differences between Recognition and Recall, Am. Jour. Psy. Vol. 24.

——— Judgments of Similarity and Difference, Psych. Rev. Vol. 20.

——— The Central Tendency of Judgment, Jour. Phil. Psy. Sc. Meth. Vol. 7.

HÖFFDING, Über Wiedererkennen, Association und Psychische Activität, Viertljsch. f. wiss. Philos. Vols. 13, 14.

HYLAN, J. P. The Distribution of Attention, Psych. Rev. Vol. 10.

KATZAROFF, D. La Recognition, Archiv. de Psych. Vol. 11.

LEHMANN, Über Wiedererkennen, Philos, Stud. Vols. 5 and 7.

LELANDE, A. Observation sur la fausse memoire, Rev. Philos. Vol. 36.

MEUMANN, Bekanntheits- und Unbekanntheitsqualitäten, Archiv. f. d. ges. Psych. Vol. 20.

McDOUGALL, R. Recognition and Recall, Jour. Phil. Psy. Sc. Meth. Vol. 1.

MOORE, C. C. Facts, the Weight and Value of Evidence, New York, 1908, Vol. 2, ch. 25.

MOORE, T. V. The Process of Abstraction, Univ. of Calif. Pub. in Psy. Vol. 1, No. 2.

MÜLLER, G. H. Über Wiedererkennen und rückwirkende Hemmung, Kong. f. Exp. Psych. v, (Berlin).

MÜNSTERBERG, American Problems, ch. 7.

——— Psychology and Industrial Efficiency.

PETERS, W. Über Ähnlichkeits Assoziation, Zeitsch. f. Psych. f. Psych. Vol. 56.

PETERSON, H. A. Influence of Complexity and Dissimilarity on Memory, Psych. Monog. 12 (42).

PHILLIPPI, J. Sur la transformations de nos images mental, Rev. Philos. Vol. 43.

RANSCHBURG, Über die Bedeutung der Ähnlichkeit beim Erlernen, Behalten, und bei der Reproduction. Jour. f. Psych. und. Neur. Vol. 5.

ROGERS, E. S. The Unwary Purchaser: A Study in the Psychology of Trademark Infringment, Mich. Law. Rev. Vol. 8.

STRONG, E. K. Effect of Length of Series on Recognition, Psych. Rev. Vol. 19.

——— Effect of Time Interval on Recognition, Psych. Rev. Vol. 20.

THORNDIKE, E. Handwriting, Teachers' College Record, Vol. 11.

WASHBURN. The Process of Recognition, Phil. Rev. Vol. 9.

WIRTH. Die Klarheitsgrade der Regionen des Sehfeldes bei verschiedenen Verteilungen der Aufmerksamkeit, Philos, Stud. Vol. 2; and Psych. Stud. Vols. 2 and 3.

INTRODUCTION

The problem of the interference of feelings is of the highest importance, both for theoretical psychology and for practical life. The general nature of the problem will be brought to mind by recalling the scene between Tubal and Shylock in "The Merchant of Venice," or the working out of the plot in "Monsieur Perrichon." The success of parents in dealing with children by "changing the subject" is due to such skill as can be acquired by experience in this field, while much of polite social intercourse, tact, and even national diplomacy has the same basis. Much depends upon doing unpleasant things in such a delightful way that anger is held in check. Similarly, a large part of the theory of apperception, association, especially the problem of hysterical amnesia, and probably also that of religious conversion (of the sort described in Begbie's "Twice-Born Men") can be much simplified by a study of the mutual influence of feelings.

As yet, however, technical psychology has concerned itself almost entirely with the attempt to discover the nature of feeling, using the methods of impression and expression, backed up by numerous physiological hypotheses. Concerning the behavior of feelings little is to be found beyond brief dogmatic statements, not based upon any general observation, e.g., "Pleasure and Pain are opposites in the strongest form of contrariety; like heat and cold, they destroy or neutralize each other."[1] Exceptions are to be found in those psychologists who have interested themselves in morals and aesthetics.[2] Much that is suggestive is to be found in works on aesthetics and literary criticism. It is, however, too indefinite to do more than serve as a good introduction to the problem. The work to be reported below was an attempt to extend technical laboratory methods into this almost untouched field. The only extensive research on the subject

[1] Bain *"Emotions and the Will,"* pp. 12-13.

[2] *Cf.* Bain. *op. cit.,* Ch. VI, under Will, "The Conflict of Motives"; also pp. 436-439.

previous to the present was that reported by Johnston, "The Combination of Feelings," *Harvard Psychological Studies,* Vol. II, pp. 159-191. His methods were considerably different from ours, but the general problems are much the same. The results should therefore be compared.

In order to indicate the nature of the sources, and also the wide range of our problem, a few of the more striking passages will be cited here.

In the Philebus of Plato is to be found the following discussion:

"SOCRATES. . . . When a person is in actual suffering and yet remembers past pleasures which, if they would only return, would relieve him; but as yet he has them not. May we not say of him, that he is an intermediate state?

PROTARCHUS. Certainly.

SOC. Would you say that he was wholly pained or wholly pleased?

PRO. Nay, I should say that he has two pains; in his body there is the actual experience of pain, and in his soul longing and expectation.

SOC. What do you mean, Protarchus, by the two pains? May not a man who is empty have at one time a sure hope of being filled, and yet in that he is empty is he not at the same time in pain?

PRO. Certainly.

SOC. Then man and the other animals have at the same time both pleasure and pain?

PRO. I suppose so." (St. 35.)

The analysis of the types of mixed feeling is given in St. 46-50.

Mixed pleasures are morbid, such as those of scratching.

"There are some mixtures which are of the body, and only in the body, and others which are of the soul, and only in the soul; while there are other mixtures of pleasures with pains, common both to soul and body, which in their composite state are called sometimes pleasures and sometimes pains."

(1) Both are due to sensations, in various parts of the body. (2) One factor is sensational, the other ideational. (3) ". . . anger, fear, desire, sorrow, love, emulation, envy and the like—pains which belong to the soul only." " . . . shall we not find them also full of the most wonderful pleasures? Need I remind you of the anger

> 'Which stirs even a wise man to violence,
> And is sweeter than honey and the honeycomb?'

And you remember how pleasures mingle with pains in lamentation and bereavement? . . . And you remember also how at the sight of tragedies the spectators smile through their tears? . . . And are you aware that even at a comedy the soul experiences a mixed feeling of pain and pleasure?"

Burke [2a] may be represented by the following:

"The Effects of Sympathy in the Distress of Others."—To examine this point concerning the effect of tragedy in a proper manner, we must previously consider how we are affected by the feelings of our fellow-creatures in circumstances of real distress. I am convinced we have a degree of delight, and that no small one, in the real misfortunes and pains of others; for let the affection be what it will in appearance, if it does not make us shun such objects, if on the contrary it induces us to approach them, if it makes us dwell upon them, in this case I conceive we must have a delight or pleasure of some species or other in contemplating objects of this kind. Do we not read the authentic histories of scenes of this nature with as much pleasure as romances or poems, where the incidents are fictitious? The prosperity of no empire, nor the grandeur of no king, can so agreeably affect in the reading, as the ruin of the state of Macedon, and the distress of its uphappy prince. Such a catastrophe touches us in history as much as the destruction of Troy does in fable. Our delight, in cases of this kind, is very greatly heightened, if the sufferer be some excellent person who sinks under an unworthy fortune. Scipio and Cato are both virtuous characters; but we are more deeply

[2a] "On the Sublime and the Beautiful." Part I, Section XIV.

affected by the violent death of the one, and the ruin of the great cause he adhered to, than with the deserved triumphs and uninterrupted prosperity of the other; for terror is a passion which always produces delight when it does not press too close; and pity is a passion accompanied with pleasure, because it arises from love and social affection. Whenever we are formed by nature to any active purpose, the passion which animates us to it, is attended with delight, or a pleasure of some kind, let the subject-matter be what it will; and as our Creator has designed we should be united by the bond of sympathy, He has strengthened that bond by a proportionable delight; and there most where our sympathy is most wanted, in the distresses of others. If this passion was simply painful, we would shun with the greatest care all persons and places that could excite such a passion; as some, who are so far gone in indolence as not to endure any strong impression, actually do. But the case is widely different with the greater part of mankind; there is no spectacle we so eagerly pursue, as that of some uncommon and grievous calamity; so that whether the misfortune is before our eyes, or whether they are turned back to it in history, it always touches with delight. This is not an unmixed delight, but blended with no small uneasiness. The delight we have in such things, hinders us from shunning scenes of misery; and the pain we feel, prompts us to relieve ourselves in relieving those who suffer; and all this antecedent to any reasoning, by an instinct that works us to its own purposes without our concurrence."[3]

Hume worked out quite a complete theory. We have already cited one paragraph. The whole passage may be given here.[4]

"Suppose, then, that the object, concerning whose reality we are doubtful, is an object either of desire or aversion, 'tis evident, that, according as the mind turns itself either to the one side or the other, it must feel a momentary impression of joy or sorrow. An object, whose existence we desire, gives satisfac-

[3] *Cf.* also Sections III, The Difference between the Removal of Pain and Positive Pleasure, and IV, Of Delight and Pleasure as Opposed to each other.

[4] Treatise, Book II, Part III, Section IX.

tion, when we reflect on those causes which produce it; and for the same reason excites grief or uneasiness from the opposite consideration: So that as the understanding, in all probable questions, is divided betwixt the contrary points of view, the affections must in the same manner be divided betwixt opposite emotions.

"Now if we consider the human mind, we shall find, that with regard to the passions, 'tis not of the nature of a wind-instrument of music, which in running over all the notes immediately loses the sound after the breath ceases; but rather resembles a string-instrument, where after each stroke the vibrations still retain some sound, which gradually and insensibly decays. The imagination is extreme quick and agile; but the passions are slow and restive: For which reason, when any object is presented, that affords a variety of views to the one, and emotions to the other; tho' the fancy may change its views with great celerity; each stroke will not produce a clear and distinct note of passion, but the one passion will always be mixt and confounded with the other. According as the probability inclines to good or evil, the passion of joy or sorrow predominates in the composition: Because the nature of probability is to cast a superior number of views or changes on one side; or, which is the same thing, a superior number of returns of one passion; or since the dispers'd passions are collected into one, a superior degree of that passion. That is, in other words, the grief and joy being intermingled with each other by means of the contrary views of the imagination, produce by their union the passions of hope and fear.

"Upon this head there may be started a very curious question concerning that contrariety of passions, which is our present subject. 'Tis observable, that where the objects of contrary passions are presented at once, beside the encrease of the predominant passion (which has been already explain'd, and commonly arises at their first shock or rencounter) it sometimes happens, that both the passions exist successively, and by short intervals; sometimes, that they destroy each other, and neither of them takes place; and sometimes that both of them remain

united in the mind. It may, therefore, be ask'd, by what theory we can explain these variations, and to what general principle we can reduce them.

"When the contrary passions arise from objects entirely different, they take place alternately, the want of relation in the ideas seperating the impressions from each other, and preventing their opposition. Thus when a man is afflicted for the loss of a law-suit, and joyful for the birth of a son, the mind running from the agreeable to the calamitous object, with whatever celerity it may perform this motion, can scarcely temper the one affection with the other, and remain betwixt them in a state of indifference.

"It more easily attains that calm situation, when the same event is of a mixt nature, and contains something adverse and something prosperous in its different circumstances. For in that case, both the passions, mingling with each other by means of the relation, become mutually destructive, and leave the mind in perfect tranquility.

"But suppose, in the third place, that the object is not a compound of good or evil, but is consider'd as probable or improbable in any degree; in that case I assert, that the contrary passions will both of them be present at once in the soul, and instead of destroying and tempering each other, will subsist together, and produce a third impression or affection by their union. Contrary passions are not capable of destroying each other, except when their contrary movements exactly rencounter, and are opposite in their direction, as well as in the sensation they produce. This exact rencounter depends upon the relations of those ideas, from which they are deriv'd, and is more or less perfect, according to the degrees of the relation. In the case of probability the contrary chances are so far related, that they determine concerning the existence or non-existence of the same object. But this relation is far from being perfect; since some of the chances lie on the side of existence, and others on that of non-existence; which are objects altogether incompatible. 'Tis impossible by one steady view to survey the opposite chances, and the events dependent on them; but 'tis

necessary, that the imagination should run alternately from the one to the other. Each view of the imagination produces its peculiar passion, which decays away by degrees, and is follow'd by a sensible vibration after the stroke. The incompatibility of the views keeps the passions from shocking in a direct line, if that expression may be allow'd; and yet their relation is sufficient to mingle their fainter emotions. 'Tis after this manner that hope and fear arise from the different mixture of these opposite passions of grief and joy, and from their imperfect union and conjunction.

"Upon the whole, contrary passions succeed each other alternately, when they arise from different objects: They mutually destroy each other, when they proceed from different parts of the same: And they subsist both of them, and mingle together, when they are deriv'd from the contrary and incompatible chances or possibilities, on which any one object depends. The influence of the relations of ideas is plainly seen in this whole affair. If the objects of the contrary passions be totally different, the passions are like two opposite liquors in different bottles, which have no influence on each other. If the objects be intimately connected, the passions are like an *alcali* and an *acid,* which, being mingled, destroy each other. If the relation be more imperfect, and consists in the contradictory views of the same object, the passions are like oil and vinegar, which, however mingled, never perfectly unite and incorporate."

Höffding considers the problem at some length, as follows:[5]

" . . . feelings . . . arise and bestir themselves more slowly than ideas. It takes longer to convert joy into sorrow than to pass from the idea of something joyful to the idea of something sorrowful. Even in persons of sanguine temperament, thoughts and fancies alter with greater rapidity than the mood. If now consciousness passes from the one of (two) given points of view (ab) to another (ac), the idea *c* will have the tendency to excite a new mood (v); but since the mood (B) excited by the first idea (b) still endures, the two moods will coincide and form a combination. It is like waves striking upon the

[5] "Outlines of Psychology," pp. 237-238.

shore; the advancing wave absorbs the receding one. In this way a mixed mood arises. . . .

"The moods of hopes and fear appear in innumerable gradations and shades, according to the relation of the possibilities to one another. . . . If the chances are thought equal, and the imagination is therefore attracted with equal force by either stream, the mind feels itself divided. Two different moods strive to expand in consciousness, but neither can gain the mastery. Hence arises the mood of doubt, the chief characteristic of which is a painful restlessness, which may excite so strong a desire to come to a decision that the nature of the decision seems indifferent if only the pain of uncertainty be ended. . . .

"When two conflicting feelings press at once to the fore and try to make themselves felt simultaneously with equal strength, there arises the intolerable sense of division just mentioned. This is, however, a rare case and of short duration. When Shakespeare makes King Claudius describe his mood at his wedding with his brother's widow as an equipoise of joy and sorrow, it is certainly the intention of the great poet-psychologist to exhibit him as a hypocrite, who betrays himself by the unnaturalness of the condition which he attributes to himself. Where the one feeling does not suppress the other or reduce it to a subordinate element, they will succeed one another rhythmically. Plato describes as follows the emotion of the disciples of Socrates during their last interview with their master. He makes Phaedo say: "I found myself in a truly extraordinary state, in an unaccustomed mixture of delight (in the matter of his conversation) and of sorrow when I reflected that he soon must die. And all present were in almost the same frame of mind, now laughing and now crying." Such an alternation is the natural state, when different motives take effect. But this cannot long continue, for the mind seeks equilibrium, and by means of memory converts the successive into the simultaneous; the two feelings are consequently blended into a new feeling, sorrow and joy, *e.g.*, into melancholy. . . .

"Sibbern has with justice therefore drawn a distinction between a mixture, or an alternation, of different or even conflicting states of feeling, and mixed feelings in the proper sense. In a mixed feeling the difference of the constituents is no longer observed, since they go to make up one single total feeling.

"Such mixed feelings comprise elements which, if appearing separately, would bear a character different from the total feeling which they help to form. . . . Here, then, are instances of psychical chemistry in the province of feeling."

Ebbinghaus relates this problem to that of atttention.[6]

" . . . die Gefühle (sind) etwas gegensätzlich Gegliedertes: ihre verschiedenen Stärkegrade bilden zwei Zweige einer eindimensionalen Mannigfaltigkeit, die durch eine Indifferenzzone miteinander in Verbindung stehen und deren Glieder die Kraft haben, sich bei gleichzeitiger Anwesenheit im Bewusstsein wechelseitig aufzuheben. Sie stehen hiermit übrigens nicht allein; bei den Temperaturempfindungen und manchen Organempfindungen (Hunger-Sättigung,-Ermüdung-Frische) finden wir Ahnliches. Ausserdem ist zu beachten, dass es zu einer vollständigen wechelseitigen Aufhebung gegensätzlicher Gefühle durchaus nicht immer zu kommen braucht, ja vielleicht in der Regel nicht kommt. Wie wir gleichzeitig an den Füssen kalt und an den Händen warm haben können, so können wir auch die Lust einer wohlschmeckenden Speise und die Unlust heftigen Kopfschmerzes neben einander erleben. Selbst ein und derselbe Gegenstand oder Vorgang vermag uns gleichzeitig lustvoll und unlustvoll anzusprechen, soweit wir nämlich in unserem Vorstellen verschiedene Seiten oder Beziehungen des Gegenstandes gleichzeitig zu umfassen und doch auseinander zu halten vermögen. Die Gefühlsbegleitung reichhaltiger seelischer Gebilde kann dadurch eine sehr verwickelte werden."

Finally, we may give the following extracts from Sully's Essay on "Laughter."

[6] Ebbinghaus, Grundzüge, I, 540-541.

"A curious fact, not as yet fully studied by the psychologist, is what may be called the inter-diffusion of characters between the several parts of a complex presentation. The figure of a finely dressed lady in a gathering of poor people may either throw the shabby look of the latter into greater relief by contrast, or redeem it from its shabbiness by lending it some of its own glory. The latter effect is favoured by a certain contemplative attitude which disposes us to look at the whole as such, and with the least amount of inspection of details and their relations. When we regard the child in the big hat a semblance of the dignity which lies in the meaning of the latter is transferred to the small head; and the mental seizure of this transferred look of dignity by the spectator is essential to a full enjoyment of the show as a bit of make-believe, of innocent hypocrisy. Similarly, if we are disposed to laugh, a little contemptuously, at the man in the child's hat, it is because the hat throws for half a moment over the heavy and lined face something of the fresh sweet look of infancy" (page 17).

" . . . among the causes of laughter, a moment's relaxation of strain—muscular, intellectual or emotional tension—is one of the most common, if it be not universal. The delicious sense of relief which the collapse of the strained attitude brings us may no doubt be due to a consciousness of the transition, the escape from pressure of the moment before. At the same time, it is not improbable that the physiological processes of laughter themselves, by securing organic relief and refreshment, contribute a large element to the whole mental state.

"A like remark applies to the element of disagreeable feeling which frequently, at least, makes our laughter a mixed experience:—

> Our sincerest laughter,
> With some pain is fraught.

Shelley was hardly the person, one suspects, to judge of the quality of men's laughter; yet his couplet contains an element of truth. This mixture of elements is, no doubt, largely due to the initiating perception itself; for . . . the laughable spec-

tacle commonly shows us in the background something regrettable. But it seems reasonable to say that the element of sadness in our hilarity has its organic support in the unpleasant feeling-tones which accompany the effects of all violent and prolonged laughter (page 46-7).

"There is no anomaly here when once we get at the comic point of view. In Molière's plays, the source of laughter lies in this very intrusion of the ill-shapen into a community of well-rounded forms. It is the intruder on whom we fix the eye, for whose unpredictable antics in a world for which he is not made our expectation is set. The serious background is there, but does not take a strong hold of our minds; we are not greatly moved, for example, by the spectacle of the sufferings of the daughters and the wards of testy old gentlemen, or even of the wearing housewifely anxieties of Madame Jourdain. The proper world, into which the absurdly ill-fitted is here pitch-forked, is but a background, rendering the valuable service of backgrounds by throwing into relief and so sharply defining the form for which the spectator's eye is accommodated" (page 369).

"In saying that we go to meet comedy in the play-mood, in which our habits of moral approbation and disapprobation, and even of estimation of social values, are lulled to a sleep more or less profound, it is not meant that these serious tendencies in us can be ignored by the writer of comedy. As implied above, they mould our forms of the seemly, unknowingly to us perhaps, even as we look. And more, though inhibited by the play-like mood, they have force; and should the showman go too far, say in the direction of stripping off the veil of decency, they may wake up and make an end of the comic enjoyment. Just as tragic fear and pity may give way to physical revulsion when horror obtrudes itself, so when in comedy the unclean thrusts into view its ugly head, a sort of physical revulsion may silence laughter. The latitude in these matters conceded from time to time to comic art will, it is evident, vary greatly with the particular ratio between the vigours of the mirthful and moral tendencies" (page 377).

"In modern literature, the interesting point to note is the growing interpenetration of the laughing and the serious attitude, and the coalescence of the mirthful spirit with sentiment. The two processes, though distinct, may run on together, as we may see in Shakespeare's plays. The humorous element introduced by the fool in 'Lear' and elsewhere, at once relieves the tragic tension, and gives a moment's play to that disposition towards a lighter laughing criticism which is always active when we survey colossal folly, even though the mental eye is at the moment focussed for its catastrophic effects. The laughter is controlled and kept tenderly humorous and half-sad by a large reflection, which does not lose sight, even at the relieving moment, of the lamentable ruin. It is only another way of combining the "fun" and the "pity" of it when the master brings a genial humour into comedy and makes us, with his faithful follower, Bordolph, half-love and more than half-pity the faulty knight who so merrily entertains us" (page 387).

Further important references are the following:—

Elsenhans. Lehrbuch der Psychologie.
Kap. III. 34. Die Verbindungen gleichzeitiger Gefühle.
Kap. III. 39. Die äesthetischen Gefühle.
Die äesthetischen Mischgefühle.
(With bibliography)

Geiger. Bemerkungen zur Psychologie der Gefühlselemente und Gefühlsverbingungen. Archiv f. d. gesamte Psych. IV (1905) 232 ff.

Lazarus. Das Leben der Seele. (Dritte Auf. 1883) 310 ff.

Lipps. Leitfaden der Psychologie. 297 ff. Mischgefühle. Konstellationsgefühle.

Moulton. Shakespeare as a Dramatic Artist. 3d ed. The whole book should be read. There is so much that bears upon our topic that it is hard to single out any one part, but the following passages are at least representative: pp. 34; 47-56; 59-61; 69-73; 325-329; 332-335; 340-355.

Rashdall. Theory of Good and Evil. Vol. II, p. 34 (not a technical discussion, but suggestive.)

Royce. Outlines of Psychology. pp. 171 ff.

Santayana. The Sense of Beauty. Part IV, especially pp. 216-7, 224-5; sections 57, 58; pp. 247-250; 255; 259.
Titchener. Feeling and Attention; especially pp. 46-55.
Wirth. Vorstellungs- und Gefühlscontrast. Zeit. f. Psych, 18, p. 49 ff.
Wundt. Grundzüge der physiologischen Psychologie. Zweiter Band. 337-341. Das Contrastprincip der Gefühle 341-353. Verbindungen der einfachen Gefühle.

REPORT OF EXPERIMENTAL WORK

The experiments now to be reported were carried on in the Harvard Laboratory, during both semesters of 1912-13 and the first semester of 1913-14. In 1912-13 the subjects were five men and three women, one of the men, "M", dropping out at midyears; in 1913-14, six men and one woman. One of the men, "K", worked throughout, the other subjects of the second year being new. All had had some experience in laboratory work.

Our task was to produce feelings as normal as possible under laboratory conditions, and in such a manner as to lead to interference. For materials, picture postcards and pictures cut from magazines, with a few from surgical books, were used. The better reproductions of classical paintings were avoided because of the difficulty of obtaining sufficiently similar, but unpleasant, materials.

Interference was secured by exposing two pictures, generally one pleasant, the other unpleasant, alternately, in a slightly modified form of the Dodge tachistoscope. (R. Dodge, An improved exposure apparatus. *Psych. Bull.* 4: Jan. 1907, pp. 10-13.) The accompanying diagrams indicate roughly the arrangement of the apparatus. The general method rests upon the known tendency of feelings to persist (*cf.* the extract from Höffding in Introduction), and upon the qualitative opposition of feelings. These two opposed tendencies give something definite to be worked out, while variation of the rate of alternation serves as an objective check upon introspection, and may lead to some insight into the rhythm of feelings.

In order to avoid distraction and external sources of feeling as far as possible, the work was carried on in one of the inner rooms of the laboratory, the walls of which are painted a dull black. General illumination was secured by means of a single drop light, in the middle of the ceiling. As the observer faced

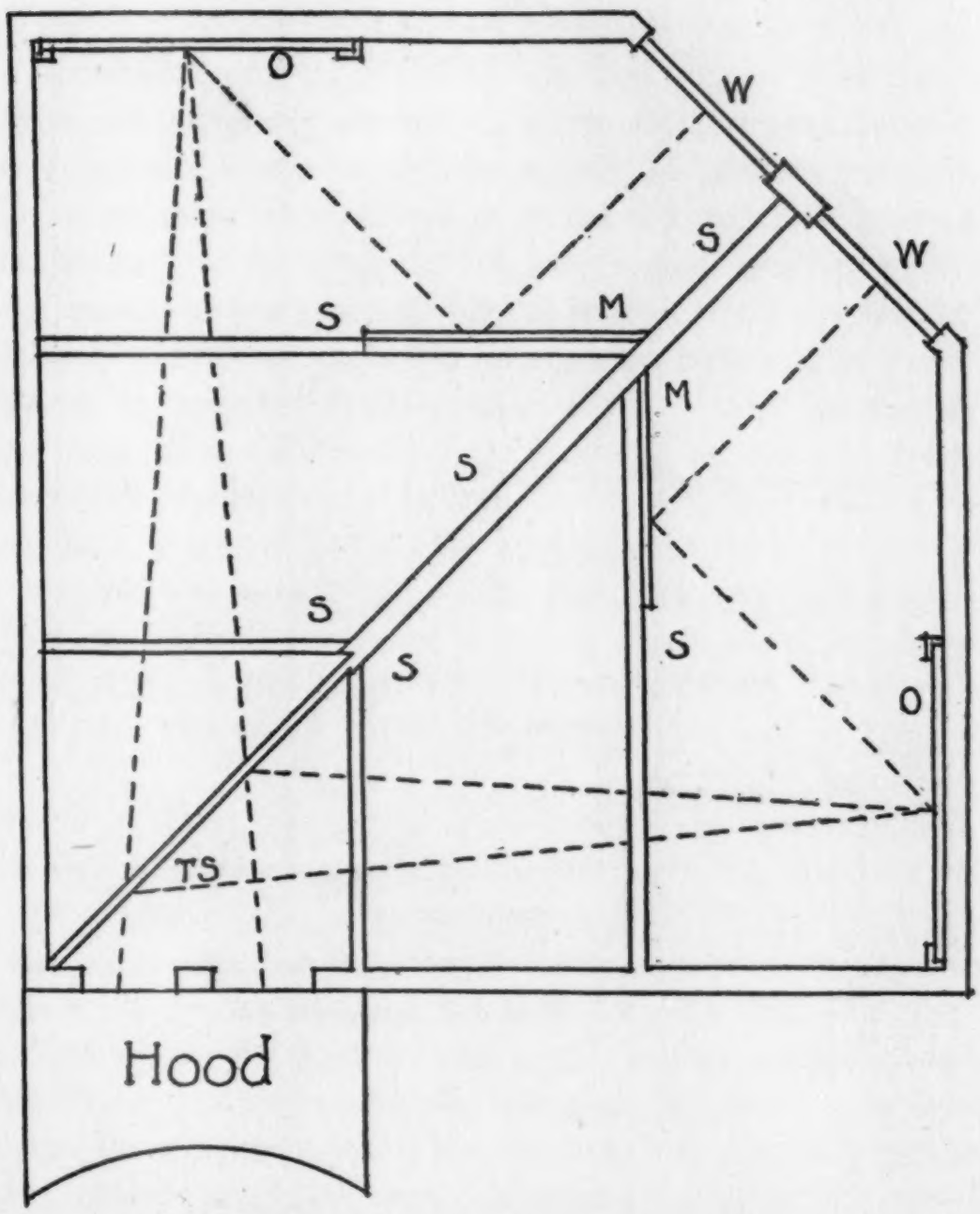
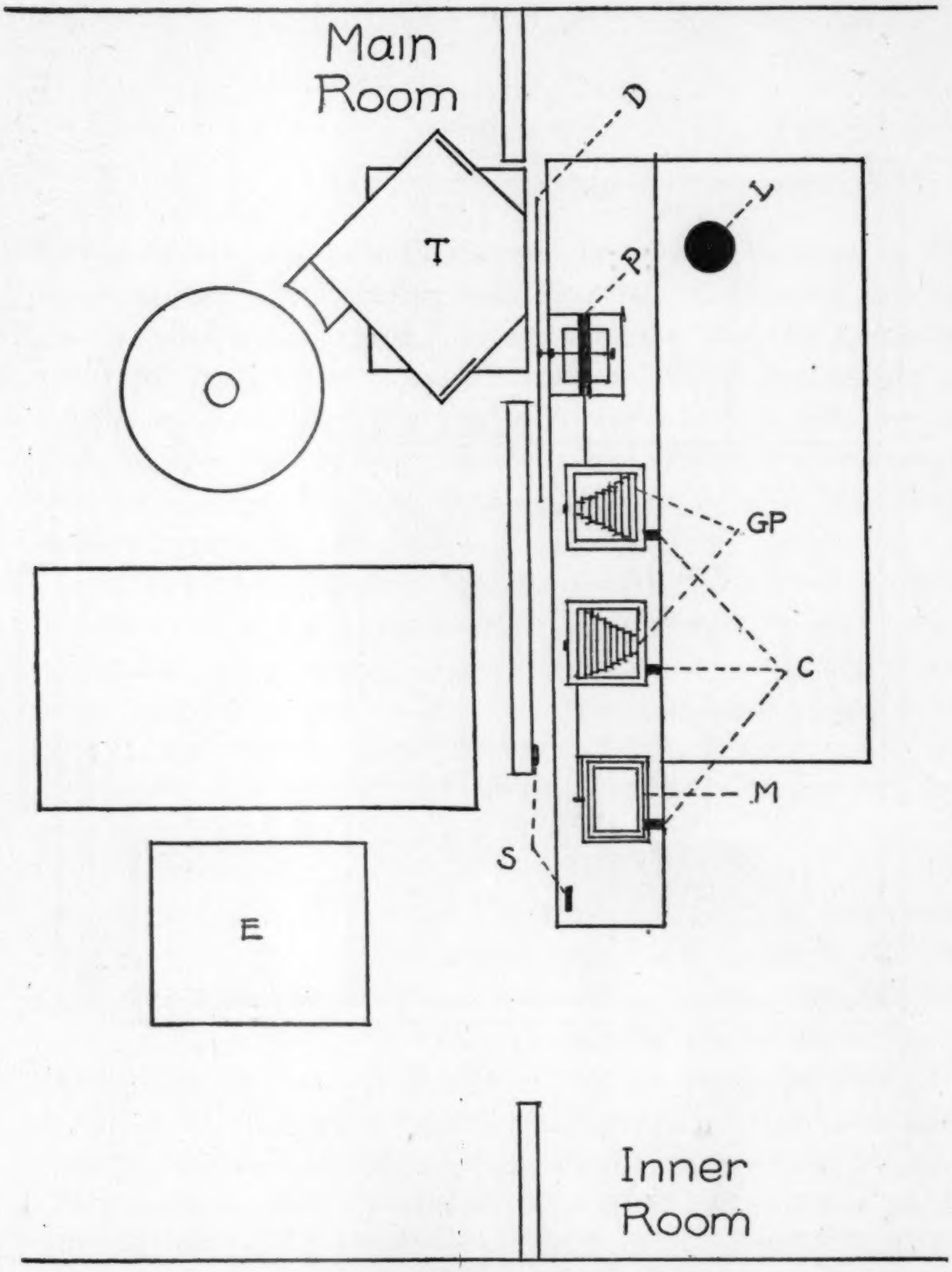


DIAGRAM OF TACHISTOSCOPE, COVER REMOVED

Following Dodge, except that the cards to be exposed are inserted through slots in the cover, instead of in the sides of the box. W W, ground glass windows; M M, mirrors; O O, objects to be exposed; S S S, screens to confine the illumination to its proper object; TS, transparent mirror. The dotted lines indicate the path of two parallel beams of light.



General Arrangement of Apparatus

T, tachistoscope, placed upon a shelf, with its double window fitting an aperture in the partition; O, observer; E, experimenter. The control apparatus was fastened by means of clamps C to a plank supported by uprights above the table in the inner room. D, revolving disk, with apertures to admit light; L, electric lamp with reflector; P, large pulley. G P, graduated pulleys for regulating speed; M, alternating-current motor; S, switchs for L and M. In each trial the motor was started, then the light was turned on for the required time. At the close the switches were operated in reverse order.

the rear of the room, this light did not interfere with the experiments, while the depressing effect of darkness was avoided.

Each subject worked one hour a week, always in the morning. No attempt was made to keep the work rigidly systematic. The number of trials, and the materials used, depended upon the tendencies and success in observation of the various subjects. In the early stages of the work the material was to some extent selected by the subjects, the latter being asked to grade large numbers of pictures roughly, as more or less pleasant or unpleasant. From the material thus grouped, the experimenter chose that to be used in the regular work. When the experimenter became somewhat familiar with the tendencies of the subjects, this method was dropped.

The work was divided into the following sections:

A (1912-13)—rate of alternation in individual trial constant.
1. Preliminary trials.
2. Tracing of the course of the feelings.
3. Description of the feelings.
4. Combination of 2 and 3.

B (1913-14)—rate of alternation varied during the trials.
1. Attention normal.
2. Attention controlled.
3. Experiments on distraction.

(The rates of alternation used ran from ten exposures per minute to about one hundred fifteen).

A summary of the methods and results in each of these, with samples from the introspections, will now be given. (In connection with the quotation of introspection the condition of the subject, unless otherwise noted, is normal.)

A. 1. The preliminary trials were intended to give the observers training in the special type of introspection necessary, and to try out the possibilties of the method. With the latter purpose in mind, no attempt was made to keep these trials systematic. Promising trials were followed out with each subject, until it seemed clear what should be done. A few representative introspections may be given.

In these preliminary trials, the directions were only general. The subjects were requested to give themselves up to the ex-

perience in a perfectly normal way, and report upon the feelings and anything else that seemed of special interest in the experience, associations when these were very noticeable, etc. The importance of this will appear later on.

We will give first a remarkably clear case of feeling-transference.

Subject "F"

Materials, Kitten (sitting on a pedestal) and No. 7, (an unpleasant surgical picture.)

Oct. 3. Trial 1. Speed 10.[7]

"The human figure was sickening, repulsive. The cat picture came as a relief; it looked snug, cozy, contented. The repulsive human figure, however, was stronger and began to lessen the relief derived from the cat. I notice five minutes after observing the two, that the kitten comes unforbidden as an image; the human figure I get by a decided effort."[8]

Trial 2. Speed 19.

"The second observation of the two pictures under more rapid change was more tolerable, the human figure made less impression than in the former exposure, the moments of relief were more prominent than before. Anticipating the human figure created an incipient shrinking attitude, while that preceding the cat created a welcome attitude."

Trial 3. Speed 36.

"The speed during third observation made the size of the human figure more effective; it dominated the field, began by eliminating the effects of the small picture of the cat. Then, too, the cat is not as attractive as in Obs. 1. I have discovered a blemish in her left foreleg which lessens the attractiveness of the picture." (In the picture, there is a very slight roughness in the fur.)

Trial 4. Speed 20.

"The human figure is absorbing that of the cat. It seemed as if the cat sat on the human figure as a sort of background. I found myself wondering how near the wound are the cat's feet, where would its head come, etc."

[7] The figures for speed here and elsewhere represent pairs of exposures per minute. The length of each trial in this series was about half a minute.

[8] *Cf.* Tate, A Short Study in Dislike, *Journ. Ab. Psych.*, 7 (1912), pp. 1-4.

Oct. 17. Trial 2. *a.* (a garden with a path) and Kitten. Speed 10.

"(*a*) pleasant; kitten has lost her pleasantness. Swelled place on leg catches attention. Unpleasant associations still last."

Trial 3. Speed 10. Kitten and Ancient (a caricature of an old maid).

"Kitten not as disagreeable, largely due to background. Other largely due to brightness. Both disagreeable, but kitten less so. Kitten has lost some of the offensiveness, the untidiness."

Nov. 7. Trial 4. Kitten and Two Fishermen. (humorous.) Speed 10. 40 seconds.

"Feeling aroused was a continuous one, humorous. Smiled throughout, the smile persisted during "cat" exposure. The cat, however, lessened, but did not suppress the humorous feeling. The latter may be represented by waves or billows, with the cat in the trough, and being borne up by the pleasant tone thus!"

"F" had forgotten his previous experiences with this kitten. He informed me that he liked cats, and could not account for his dislike in this case. I believe that the whole apperceptive attitude and feeling persisted from the surgical picture, and fixed upon the very slight defect in the picture of the kitten.

The following selections bring out the influence of the various speeds:

Subject "I". Oct. 24

Trial 1. Brook in Middlesex Falls and It (a dude). Speed 10. 20 seconds.

"Pleasant picture produced more of an impression; noticed tendency merely to stare at the other. Very strong feeling tone for the pleasant picture, mildly unpleasant tone for the other. Running water very strong impression, kinaesthetic imagery held over. "It" forgotten as soon as he disappeared. Pleasant feeling lasted a little while. Other picture delayed in coming in; lines just stood there blankly for an instant."

Trial 2. Material same. Speed 19. 20 seconds.

"Very much the same. . . . Great persistence of the picture of the brook, active associations . . . enter into scene. Other regarded more impartially; man does not seem so real, does not take hold so much."

Trial 3. Same. Speed 36. 20 seconds.

"Harsher aspects of man come in more strongly. Pleasant did not have time to develop fully; apparently pleasantness takes longer to come as well as longer to go. Feelings more evenly balanced."

The following trial with the same subject gives a case of fusion.

Trial 4 of same date. "It" and No. 24 (a house) (24 chosen as mildly pleasant by "I". Speed 10. 20 seconds.

"Foolish picture had the advantage. No persistence of imagery, but feeling tone seemed to fuse with the other. "24" is given a slightly disagreeable tone."

Increase of speed in the next trial again favored the unpleasant.

Subject "M" frequently reported parallel feelings, as in the following cases:

Oct. 18. Trial 1. Fabriola and No. 41 "M" sleepy. Speed 19. 45 seconds.

"Two streams of feeling, one serious and the other comic. A sort of continuity. *The streams run along parallel, varying in strength according to the pictures in view. Both pleasant, but in a different way.*"

Trial 2. Same. Speed 10. 40 seconds.

"A little change . . . familiarity. Feeling decreased, but equally. The streams got so thin sometimes that they broke. Otherwise similar to previous."

Trial 3. Same. Speed 29.

"Village schoolmaster more comic, thought of that picture more. The stream of comic feeling was unbroken, not sure about the other."

Oct. 25. Trial 1. "Mona Lisa" and "God Help the Poor Sailors" etc. (a comic drunk) "M" sleepy. Speed 10. 60 seconds.

"One funny, the other pleasant. . . . No noticeable change in course of trial. *Two streams of feeling, emphasized in alternation.*"

Oct. 25. Trial 6. La Vergine Afflita and Two Fishermen. Speed 10. 40 seconds.

"One agreeable, other funny, no conflict. Feeling tones lasted throughout."

With pleasant and unpleasant there seems to be more interference.

Oct. 25. Trial 3. Whittier Falls and No. 92. Speed 10. 20 seconds.

"One pleasant all the time, the other disgusting. *Contrast made pleasantness stronger, and the pleasantness seemed to last and be contrasted with the disgust during exposure of "92."* This was not true in the other direction. The pleasant feeling was pure.

Subject "I" was especially sensitive to the effect at transition.

Oct. 3. Nos. 7 (surgical) and 17 (landscape). Speed 24.

"Landscape first . . . seemed all the way through as if it were exposed longer than the man. During the first half of trial, agreeable outweighed disagreeable feeling. Then the disagreeable began to come in stronger. Began to think more about the man. But that lasted only a short time. Then came a return to first.

"Seemed to anticipate the pleasant picture; trees loomed up through the other picture before transition. Landscape more complex. Disagreeableness of other gave way at times to monotony. Transition contrast worked in favor of pleasant. Did not accentuate the other."

Oct. 10. Boy in Red (Le Brun) and No. 12. Speed 10. 20 seconds.

"Two make practically the same amount of impression. At moment of transition always a little discomfort. With the agreeable picture this was immediately followed by a contrast effect, more agreeable than otherwise. With the disagreeable, the feeling accumulates."

Trial 4. No. 49 and Madame Recamier. Speed 10. 20 seconds.

"Madame made stronger impression. Contrast very marked, more so in transition to the unpleasant. Other way, disagreeable feeling seemed to carry over, so in this direction there was subtraction. Seemed to attach less real meaning to the bad one than to the other."

Subject "K" seems occasionally to have objectified the transition effect in a curious way.

Oct. 9. Trial 7. No. 92 and Mona Lisa. Speed 72.

"Change unpleasant for eyes. Spite, competition going on. Indifferent about competition, yet wanted to see pleasant picture, couldn't get enough of it at that rate."

Trial 9. Same. Speed 48.

"Feelings more marked, more time to notice every feature. Two pictures seem to be fighting. Pleasant one is disdainful, admiration for her increased."

Trial 10. Same. Speed 20.

"The fight is over now, and the pictures are separately related to me. Mona looks more serene now,—feeling of pleasantness greater. Other unchanged."

Such results are quite frequent with this subject, and occur occasionally in the work of some of the others.

The above selections are, I think, sufficient to show the nature of the problem, which was the purpose of this section of the work. Accordingly we may leave the preliminary experiments without attempting any more complete report.

A. 2. Tracing Course of Feelings.

The method of this section was suggested partly by the nature of some of the introspections given in the preliminary trials, partly by the familiar criticism, concerning so-called 'mixed feelings,' that these states may be really cases of rapid alternation (*cf. e.g.* Titchener, Textbook, p. 236). It was thought that this question could best be settled by concentration upon the temporal aspect of the experience. In this connection a reply to a common form of the above criticism may be offered.

We often hear of an alternation too rapid to notice as an explanation of mixed feelings, divided attention, etc. Now, while this explanation may possibly serve physiologically,—I do not care to discuss that question here—psychologically it can hardly be valid. An alternation too rapid to be detected is not a conscious alternation, and it is consciousness with which we are concerned at present. Hence, I feel no hesitation in accepting the results of careful introspection, given immediately after a brief exposure of the stimuli. With long trials, I should feel some hesitation owing to the liability of confusion in memory. This, however, brings up an interesting problem. Suppose that mixed parallel feelings are reported. The suggestion of a confusion in memory, some sort of telescoping of the experience, may be valid as against the truth of the statements with re-

gard to the experience during the trial. But what of the experience at the time when the statements are made? The statements must have some basis. Then do we not face a choice between belief in affective imagery and belief in mixed feelings? I assume that every judgment has some basis in present experience even though its reference is to the past.[9]

In order to understand more easily the reports of my subjects, I occasionally tried an experiment with myself as subject. A few of these were recorded, and I will quote them under my own name, to keep them distinct from the work of the subjects. This is in deference to the opinion of those who hold that the experimenter should not make use of his own introspection.[10]

As an introduction to the general method of the present section, I will quote one of these forbidden introspections.

Kellogg

Nov. 1, 1912. Fairly good condition, a bit sleepy. Speed 10. (Length of trial could not be recorded, about a minute, at a guess). No. 3 (surgical) and What are you Laughing At (comic).

"The exposures of 3 seemed to grow longer, of other shorter, as trial went on.

"3 came first, bare apperception, not a trace of feeling. Other slightly humorous. . . .

"Second exposure of 3 very disgusting. No empathy or sympathy noticed in whole trial, just disgust. In one or two scattered exposures the feeling seemed to lose hold somewhat, but in general it increased during the trial.

"At first the feelings were broken off sharply with the shifting. Then the disgust began to get the upper hand, began to hold over, but there was at first no blending. The disgust simply held the humor back. I noticed that I tried to get the humor and get rid of the disgust. This failed; the delay continued. Then the effect changed again. The disgust lasted, and the humor, though delayed a little, began to come in before the

[9] *Cf.* Russell, "The Problems of Philosophy," p. 91

[10] *Cf.* the discussion by Alechsieff, in Section III of his article on "Die Grundformen der Gefühle" *Psych. Studien* 3 (1907), pp. 156-271.

disgust was gone. The disgust began to hold over longer and longer each time, until finally it was continuous. Its strength in the intervals also increased, until at the end the feeling was as strong when the picture 3 was absent as when it was present. At the same time the humor began to come in more nearly at the beginning of the exposures, overlapping more and more. Then there was anticipation of it during the close of the exposure of 3, and finally this feeling too seemed to be continuous. The simultaneity of the two incongruous feelings seemed queer. Then a new feeling of displeasure at the situation came in, and I stopped looking.

"The shifting as such was never other than indifferent. Did not notice any eye-strain.

"The two feelings, when finally simultaneous, seemed to be partially, but only partially, fused. I could not say that there was a thoroughly unified resultant emotion.

"This partially fused emotion was taken in a somewhat impersonal way. My attitude was to a slight extent that of a disinterested spectator, until suddenly the feeling was strongly realized as my own, and the new displeasure mentioned above came at once. . . .

"As the feelings were growing towards fusion, I found myself saying, What is so funny, anyway?

"The visual imagery did not generally hold over. Once, about the middle, imagery of 3 did last into exposure of other picture."

In the work of this section no attempt at rigorous analysis of the feelings was made. They were for the most part merely named as well as might be. The subjects were asked to attend carefully to the time order of the feelings.

In order to get further light on the mutual influence of the feelings, check experiments were often made use of.[11] In these, the pictures of the main trial were alternated with a plain white card, or with a period of darkness.

The check trials for the above were made with the following results:—

[11] In all that follows, introspections should be read carefully, in groups—check trials with main trials, and trials with different speeds. Much that seems wholly trivial in the rough statements of the notes, is full of meaning when read in this way.

What Are You, etc., and darkness interval. Speed 10, about half a minute.

"Feeling mild humor, continuous. No breaks in intervals. Did not weaken in intervals either, except once, slightly, about middle of trial. General course practically level.

"Intellectual attitude in intervals shifted, sometimes reminiscent, sometimes expectant.

"The coming of the dark intervals was a trifle disagreeable sometimes. At these times, the humor was a little impeded just at the beginning of the dark period, but there was no break.

"No visual imagery in intervals."

No. 3, same way.

"First time, bare apperception. Then in the later exposures a mild dislike came in. Varied in strength. . . . There was a period of indifference in the middle of the trial. Picture seemed a little unreal throughout. Disgust was very mild. Anticipation came into some of the intervals, and there was some unpleasant feeling then. Usually the feeling dropped at once at close of exposure, but occasionally it died away slowly. Sometimes it was cut off sharply by a pleasant feeling which came from the richness of the black. No visual imagery."

(I believe now that the duration of these trials was considerably longer than the estimate quoted from the notes. I may add also that the experience of the main trial made a very vivid impression upon me. At various times for some weeks thereafter I found it possible to go through it in memory with no external aids. Even now, in March, 1914, when writing out the passage referring to the partially fused experience, I had a similar feeling, a complex of pleasure, displeasure, and a marked tension, with faint traces of visual imagery. This being so, I can hardly doubt the validity of the original report.)

Another example will serve to show the need for care, as the displeasure changed to sympathy before the parallelism came in.

Kellogg

Nov. 15, 1912. Excellent condition. Speed 24. Time seemed about a minute. Sunset at Woods Island and Dachshund.

"Dog first, seemed long exposure. Cold recognition. Sunset pleasant as soon as seen, mild feeling. Dog very slightly unpleasant next time. Then for a few exposures attention was

rhythmical. Sunset vivid and pleasantness stronger, but stopped with picture. Exposures of dog almost a blank, but a trifle disagreeable. Then attention suddenly shifted. Dog was the stronger for one or two exposures, but sunset not inhibited to so large a degree as dog had been. Then the process seemed to get mechanized; a pulse of attention (a slight tension noticed) for each picture, not quite at beginning of exposure. I seemed to favor this rhythm. The transition from one feeling to the other was very interesting. Feeling for dog gradually became more sympathetic and very slightly humorous. Then the feelings began to hold over; did not inhibit each other, but overlapped. At end of trial both were continuous, and from merely running parallel they began to fuse. Seemed to form one feeling, regardless of alternation.

"The shifting was not unpleasant as such. Difference in eye accommodation for two pictures seemed to influence attention at first. Then became mechanized and was no longer noticed."

The greater part of the work in this section was done with speeds 10, 24, and 36. Examples will now be given from the results with each subject. In several cases, the same material was used with various subjects, but in any case, consideration of the individual differences is of interest.

Subject "J"

Oct. 31, 1912. A little excited, mild unpleasantness.

Trial 1. Speed 10. 10 seconds. No. 3 and dark interval.

"Two exposures, light grows slowly, attention concerned wholly with light at first. Then picture broke upon consciousness,—a tremendous pulse. Grew to its height just as the light began to fade again. (Strong bodily reaction.) Feeling faded a good deal with the light, but an amount of unpleasantness remained, and this lasted right through the interval. Second exposure merely continued this feeling."

Trial 2. Speed 10. 10 seconds. Georgetown Road (a road at the university), and dark interval.

"Three distinct pulses of consciousness in the first exposure; 1, perception, clear and distinct by itself; 2, 'I've seen that before' in inner speech; 3, mild pleasantness. Feeling persisted through interval, also perseveration of "2."

"Second exposure, associations,—Berlin, etc., but feeling-tone not increased. Afterwards feeling of pleasantness increased markedly."

Trial 3. Speed 10. 20 seconds. No. 3 and Georgetown Road.

"3 came first, came with a shock, but not so much feeling.

"(Road), no feeling till towards end, not very strong.

"3 next, indifferent.

"Road, pleasantness came in a little earlier and was stronger.

"3rd exposure of 3 indifferent.

"Road, race of 'peristaltic' feeling. A very vague, fleeting feeling of pleasantness, scarcely above indifferent.

"Two curves entirely discontinuous."

Nov. 14, 1912. Trial 1. Speed 24. 40 seconds. Audrey Burton (from Red Book) and Mosquito (magnified).

"The bug first, just a flash of exposure; then the other, purely intellectual. 2nd exposure of bug cold too. Then girl again, very pleasant. For a while alternation of pleasure and indifference, sharp cut. Then came a desire to see more of the portrait; other attracted attention less. At end imagery of outline of portrait was seen upon the other picture, and pleasantness held over."

Trial 2. Speed 24. 20 seconds. Mosquito and white card.

"Whole time in blooming wonder as to what the thing was. Blank card entirely too bright; tension, strain, all the time, yet a great deal of interest. Desire to find out what was there, mildly pleasant."

Trial 4. Speed 24. 20 seconds. Audrey Burton and white card.

"Pleasant; she's a dear. . . . *When attention is concentrated sharply, feeling-tone disappears.* Tried this with the after image. (Negative after image came on the other card.) *General organic sensations and tonus of body continue, but feeling-tone disappears.* Pleasure continuous, except when attention is strained." (N. B.)

Nov. 21, 1912. Speed 36. 40 seconds. (Heavy organic feeling all over, just slightly unpleasant.) Lovers' Retreat (East Northfield) and No. 38.

"First an effort of adjustment, focusing of attention. Time very short. Both indifferent till very near close. Then dog called up associates, pups in Berlin—feeling of amusement. Tried to get the woods clear, but no feeling for this picture at all. When attention is focused upon one picture the other is just a blur. A good deal of strain in the experience. Sensations localized in solar plexus, in eyes, and in forehead."

Trial 2. Speed 36. 40 seconds. Lovers' Retreat and dark interval.

"Logically pleasant, in a few cases a relief from the general feeling-tone. Connected with empathy. Not positively pleasant, merely inhibited general unpleasantness."

Trial 3. Speed 36. 40 seconds. No. 38 and dark interval.

"Colors clear, outlines difficult to grasp. No feeling except a slight relief from organic sensations. After about half the time turned his attention to transition from picture to interval. Organic sensations disappeared with picture each time and then swept back in interval."

Subject "I"

Oct. 31, 1912. (Fairly pleasant) Speed 10. 10 seconds. No. 3 and dark interval.

"Grew continually more disagreeable; at its height when light was cut off. Image lasts and feeling-tone lasts with it. Image died out first, then feeling faded; but when picture came again the feeling seemed to connect with a process still going on; no break. Feeling for second exposure stronger. Seemed to begin where the other left off.

"At the very beginning, a noticeable interval for apperception. First, just something on paper, then gradually seemed to represent an actual experience of a person."

Trial 2. Georgetown Road and dark interval. Speed 10. 10 seconds.

"Feeling-tone came out very quickly. Almost felt as if running to meet it. It developed continuously, increased to very end. Persistence of image in interval much more marked."

Trial 3. No. 3 and Georgetown Road. Speed 10. 20 seconds.

"Visual image of road as mere sense-impression lasted longer and came more immediately to clear focus at each new exposure.

"Feeling-tone of injured man lasted even during recognition of road. Whatever sympathetic processes were made active by the unpleasant picture were less easily inhibited than those from the pleasant picture which were more easily excited in the first place."

Nov. 14, 1912.

Trial 1. Hazel Troutman (from Red Book) and Ancient. Speed 24. 60 seconds.

"Preference very marked, improved at each exposure. Displeasure as much due to the cutting off of the good picture as to the bad picture itself. Contrast favored pleasant picture; anticipatory image. Tried to neglect unpleasant picture. Feeling

did not increase as trial went on. Pleasantness did not seem to be entirely cut off by unpleasant."

Trial 2. Ancient and dark interval. Speed 24. 30 seconds.

"Certainly disagreeable enough; gets worse and worse. More activity in intervals toward end than at beginning. Unpleasantness continuous. *During intervals attended more to feelings. This reinforced feeling.*" (N.B.)

Trial 3. Hazel Troutman and dark interval. Speed 24. 30 seconds.

"Development similar. Continuous increase of pleasantness. *Same reinforcement of feeling by attention to it in intervals.*"

Nov. 21, 1912. (Pretty fair.)

Trial 1. Sunset at Woods Island, and God Help the Poor Sailors, etc. Speed 36. 40 seconds.

"Agreeable picture predominated from outset. Persistence of pleasant feeling during exposure of ugly picture. Involuntarily disregarded what was most unpleasant in picture. Fixed on the neutral features. This tendency stronger with each new exposure, while sunset grew more and more agreeable. The ugly picture eventually grew meaningless, except as a rather annoying halting-place between exposures of the other."

Trial 2. Sunset and dark interval. Speed 35. 40 seconds.

"Pleasantness broken by the blackness of the interval, as if there were a dark storm, and the other scene were exposed by a flash of lightning. Interval unpleasant. Feeling almost like fear. Almost destroyed pleasantness towards end."

Trial 3. G.H. the P.S. etc., and dark interval. Speed 36. 40 seconds.

"Imagery lasted. Memory and anticipation. Feeling continuous and increased. Character of feeling changed:—annoyance, contempt, anger."

Trial 4. Sunset and white card (to correct Trial 2). Speed 36. 40 seconds.

"Quite a different effect. Pleasure increasing. More details kept coming in. 1, boat; 2, boat and water; 3, boat, water and sky, etc. Pleasure more extensive.

"Imagery lasted very slightly. Feeling passive, died out rather quickly. Advance in feeling due to adaptation. (Pleasure aroused by these pictures is usually passive, displeasure active.")

Trial 5. The Lily Pool, and No. 38. Speed 36. 40 seconds.

"Very much like exposure of the other two. Interest more

active in case of pleasant picture. Awoke sympathy. Other picture seemed comparatively insignificant, and as before I disregarded unpleasant features as the pleasant feeling of first picture increased. Marked persistence of both imagery and feeling from lily pool even to extent of interfering with clear apprehension of ugly picture."

Subject "F"

Oct. 31, 1912. (Very well, but has been working with asafoetida, and the odor persists in his consciousness.)

Trial 1. Georgetown Road and dark interval. Speed 10. 10 seconds

" . . . A wave of pleasant feeling during first exposure. Feeling in interval comfort, pleasant anticipation. Interval seemed long, but not tedious. Second exposure still more pleasant. Feelings in interval and during exposures were of different sorts."

Trial 2. No. 3 and dark interval. Speed 10. 10 seconds.

"Cringing in short first exposure. Other two were long. In last one the bodily reaction died away. The second exposure was the most disagreeable. . . . Inner speech 'That's one of those horrid wounds'. In last one, curiosity concerning location, so height of feeling was in first long exposure. Feeling of relief at close of exposure in all three cases. The curiosity in third was like whistling to keep up courage. Cringing, etc., came very quickly. After feeling of relief, between exposures, there came a curiosity—'How did I feel?' but unpleasant feeling did not persist. Now after trial, the imagery lasts, but the feeling is gone."[12]

Trial 3. Georgetown Road and No. 3 Speed 10. 20 seconds.

"3 first—expectation. Road—surprise, great relief, feeling of coolness. On return of 3, feverishness. This seemed to be due to influence of road picture,—transference and reversal."[13]
"Road-relief not so great, intention to enjoy picture as it passed. 3 . . . voluntary aspect of reaction,—attention to rim of wound. Same curiosity effect as before. . . . "

Trial 4. Repetition of previous.

"Feeling-tone less in both cases. Road first. 3 dominant throughout. R. on the defensive against the wound picture.

[12] *Cf.* Titchener, *Feeling and Attention*, pp. 61-65.

[13] *Cf.* the quotation from Darwin, Titchener, Textbook, p. 487; also Féré,—L'anthithèse dans l'expression des émotions, *Rev. phil.* 42, pp. 498-501.

Effort required to enjoy; repulsion comes of itself. Started with a low feeling-tone. Not a strong feeling at the end. Feeling for R. gradually driven out."

Nov. 14, 1912. (Very well.)

Trial 1. Hazel Troutman and Ancient. Speed 24. 60 seconds.

"Feelings sharply opposed. Ancient remained on the same level, attitude did not change. Young lady increasingly attractive. Possibly the unpleasantness was assimilated to the other somewhat and tolerated. Tendency to idealize the good one, read a lot into it. Other just taken as it is."

Check trials were made, but one of them failed, as will be seen.

Trial 2. Ancient and dark interval. Speed 24. 30 seconds.

"Tendency to revive imagery of H.T. in proper places. Seemed to relieve the effect of this. Tried to follow directions by centering attention upon this picture, but could not. Practically a repetition of former experience."

Trial 3. Hazel Troutman, same method.

"On the whole, the feeling rose,—continuous. Other 'girl' butted in once or twice, but did not detract. Came in during exposures, not in intervals."

Trial 4. No. 8 (Niagara) and No. 96 (Bowlegs, comic). Speed 24. 40 seconds.

"Man more or less comical, feeling did not increase. Other—awe, dignity, power. *Pleasant, feeling increased. This feeling continuous; feeling for man broken after each exposure.*

Trial 5. No. 96 and dark interval. Speed 24. 30 seconds.

"Feeling not as humorous, unpleasant aspects come in. Pleasant at first, then unpleasant and stayed so, continuous."

Trial 6. No. 8, same way.

" . . . Intervals seemed to be same as my winking, just as if exposure were continuous. Cool feeling, etc. Bridges in distance noticed. More interest as trial went on. Pleasantness did not increase . . . continuous."

Nov. 21, 1912.

Trial 1. Lovers' Retreat, and God Help the Poor Sailors, etc. Speed 36. 60 seconds.

"At first two distinct feelings, (a) pleasant, (b) disgust. The pleasurable tone increased on its own account and encroached on the other. This continued until *the pleasurable tone carried over from exposure to exposure, thereby becoming continuous,*

the disgusting picture coming in as a check or damper on the pleasurable tone.[14] The pleasurable tone grew in two directions, backward and forward, the former as a pleasant lingering tone, and the latter as anticipatory and of course pleasant."

Trial 2. G.H. etc., and dark interval. Speed 36. 60 seconds.

"Disgust at first, then gave way to incipient sympathy, then gave way to humor. Noticed that everything was in curves. No breaks in feeling during intervals. Intervals hardly noticed."

The other check trial is unsatisfactory, i.e. as such. It has, however, an independent value.

Trial 3. Lovers' Retreat, and dark interval. Speed 36. 60 seconds.

"Intervals came in as an interruption. Blackness seemed to cut off feeling. Scene changed from a warm summer scene to a cold winter scene. Began to shiver. Contrast with the warmth unpleasant. Distinct organic reaction. The shift was rapid, no lingering."

Subject "H"

Nov. 1, 1912.

Trial 1. Georgetown Road and dark interval. Speed 10. 24 seconds.

"Was expecting a steady exposure; very much annoyed by the black interval. This seemed longer than the exposure.

"Feeling first pleasure in the subject of picture. Then seemed to feel myself in that situation. Then the scene began to shift to my own woods. This was cut off by the ending of the exposure.

"Feeling during intervals, annoyance. Wiped out image of picture. Mind seemed to be a blank."

Trial 2. (getting sleepy). No. 3 and dark interval. Speed 10. 24 seconds.

"First two exposures, amazement. Feeling-tone for picture itself, sinking, dread. Seemed to get ether smell. In last two exposures feeling-tone entirely the sinking, dread; very unpleasant. Dark intervals very pleasant."

Trial 3. Georgetown Road and No. 3. Speed 10. 24 seconds.

"Pleasure overbalanced the displeasure. No surprise this time; sinking not noticed.

[14] A case of algebraic summation.

"Pleasant feeling begins the moment the picture appears, just the same as real scenes. Other just slightly unpleasant. Made a conscious effort to endure it. Less unpleasant than the black intervals in case of road alone.

"Pleasant feeling seemed to last during exposures of 3, but under a mist."

Nov. 15, 1912.

Trial 1. Audrey Burton and Ancient. Speed 24. 40 seconds.

"At first amused at both of them. Caricature ridiculous, but lost that character after about three exposures. Audrey a little bit silly-looking at first, but gained in pleasantness. A very decided relief in contrast with other.

Trial 2. A.B. and dark interval. Speed 24. 40 seconds.

"Didn't like her posing, so shifted her all round, and made a pretty little girl of her."

Trial 3. Ancient, same way.

"Terrible. Dreaded it before, and could hardly keep still while looking. No intervals remembered; feelings unbroken."

Nov. 22, 1912. (most indifferent, unpleasantness hangs over from yesterday.)

Trial 1. Hazel Troutman and Ancient. Speed 36. 40 seconds.

"Pretty distinct. Exposures of Ancient seemed much the longer at first and grew more so.[15] About halfway through there was a drop in the attention. Strain of shifting unpleasant. Girl a great relief in contrast with other. Ancient very annoying at first; a person making up faces, not a caricature. After attention came back the pleasant one was much more prominent, its exposures seemed to grow longer. Ancient not blotted out, but effect diminished. Pleasant feeling lasted into exposures of unpleasant, floated out gradually. Unpleasant feeling lasted in opposite direction, but was cut off sharply. Feelings did not seem to run parallel anywhere."

Trial 2. H.T. and dark interval. Speed 36. 40 seconds.

"Intervals much longer than exposures. Girl very pleasant, but as it went on, she came to have a pained expression. . . didn't seem happy. Intervals seemed a little annoying, but a rest from the strain of looking;—felt that it was needed. Strain seemed to influence attitude towards picture, the interpretation of it."

[15] The illusions in perception of time due to different intensity of feelings are worth noting.

Trial 3. Ancient, same way.

"Wasn't conscious of any intervals at all until about half way through. Picture very unpleasant from the start. . . . Feeling got worse as time went on. When intervals were first noticed, they were a great relief. Last two times anticipation came in unpleasantly. Shivers ran up arms and back. Intervals seemed very short even when noticed."

The following will serve as a good illustration of the queer things that will sometimes happen.

Subject "L"

Nov. 1, 1912.

Trial 2. Falls of Song. (Ossipee) and dark interval. Speed 10. 45 seconds.

"Got auditory imagery, very tiresome. Intervals, suspense. Seemed to be trying to hold the whole thing up. No change in strength of feeling. Intervals seemed to be long. (Have always had a horror of falling water.)"

Trial 3. Among the Poppies, and dark interval, same way.

"As a whole, feeling quieting, but black hair of one child annoying. Length of intervals seemed to vary. When they were long, felt a strain, tension. No other feeling-tone during intervals. Strength of pleasant feeling did not vary, until black hair was noticed. Then attention wavered between the hair (unpleasant) and the rest of the picture (pleasant)."

Trial 4. Among the Poppies and Falls of Song same way.

"Poppy feeling tiring, children inquisitive about flower—empathy. Water quieting, pool at bottom pleasant. No auditory imagery. Feelings coextensive with the exposures. No changes noticed."

Such generalizations as that in Trial 2 do not seem to be of great value. In addition to Trial 4 above, consider the following:

Nov. 22, 1912.

Trial 6. Lily Pool and Whittier Falls. Speed 10. 20 seconds.

"Auditory imagery of falls. Pictures distinct. Falls more vivacious, both pleasant. Familiarity of pool lessened feeling."

Subject "M"

Nov. 15, 1912. (Sleepy.)

Trial 1. Sunset, Woods Island and Dachshund. Speed 24. 40 seconds.

"Dog funny, other slightly agreeable, so feeling on the whole agreeable, very slightly. Seemed like one continuous mildly pleasant feeling."

Trial 2. Sunset and dark interval. Speed 24. 20 seconds.

"Agreeable, very slight trace of feeling, none in intervals."

Trial 3. Dachshund, same way.

"Funny all through; feeling not broken by intervals."

Nov. 22, 1912.

Trial 1. Among the Poppies and No. 7. Speed 36. 40 seconds.

"One was positively disgusting, the other quite agreeable. Transition from pleasant to unpleasant a shock, uneasiness. Transition in opposite direction a relief. Feeling of disgust the stronger. Increased during each exposure. Both feelings increased as trial went on, disgust more so than pleasure."

Trial 2. Among the Poppies and dark interval. Speed 36. 30 seconds.

"Agreeable throughout. Increased after the first few exposures. Intervals, agreeable expectancy."

Trial 3. No. 7 and interval, same way.

"Exposures as disagreeable as can be. Intervals came as a sort of relief, then apprehension came in."

In the following case this subject was asked to pay particular attention to the transitions:

Nov. 15, 1912.

Trial 5. Among the Poppies and "It". Speed 24. 40 seconds.

"Agreeable and unpleasant. Transition a shock in both directions; tension, aversion, and expectancy, but both slight. Heart beats noticed at transition; beat stronger just before good picture; before the other seemed to slow up. This was noticed only a few times. At increase of speed in pulse, a little feeling of excitement, elation. Pleasantness comes as soon as picture is seen. After the good picture there is a break in the feeling. Uneasiness comes with the decrease of pulse and the unpleasant feeling joins this feeling when the picture appears."

Trial 6. Among the Poppies and dark interval. Speed 24. 30 seconds.

"Quickening of heart beat before picture, lasts through exposure, dies out slowly afterwards. Feeling of expectancy. Pleasantness seemed to be correlated with pulse."

Trial 7. "It" same way.

"Same effect reversed. Feeling is stronger when the pictures are alone than when they were together."

Subject "C"

Nov. 13, 1912. (A little sleepy.)

Trial 1. Lily Pool, and What Are You Laughing At? Speed 10. 40 seconds.

" . . . Old duffer silly and smirky. . . . Pleasantness increased, for children. The unpleasantness also increased. About equally divided."

Trial 2. *A*, and fly's head (much magnified). Speed 10. 40 seconds.

"Road came first, pleasant; later, only mildly so. Fly—first, thought if was a diseased one, creepy. Then a fly's foot. Then a plant; interesting, displeasure faded."

Trial 3. *A* and a white card. Speed 10. 20 seconds.

"Really very nice, had no idea that it was so pleasant. Grew pleasanter all the time. Intervals seemed fearfully long, wanted to get back to it. Depends more on associations than on artistic character."

Trial 4. Fly's head, same way.

"First just interested, then began to think of germs, fly-killing contests, etc. Felt flies crawling in hands; feeling grew worse and worse all the time. Don't remember any intervals."

Subject "K"

Nov. 6, 1912. (More cheerful than usual, a little sleepy.)

Trial 2. Among the Poppies and white card. Speed 10. 24 seconds.

"Feeling at its maximum at the very beginning of the whole exposure. Bright, cheerful, intervals unpleasant. Feeling steady during separate exposures, but decreased from beginning to end of trial as a whole."

(This seems a rather unusual mode of behavior of feelings. Subject "H" reported a somewhat similar effect with this same picture in a check trial Nov. 1. The "feeling-tone increased up to the sixth (exposure), then diminished. Intervals passive. Feeling level during single exposures."

Trial 3. No. 3, same way.

"Revulsion increased during period as a whole, also during separate exposures. Intervals more indifferent than in previous trial."

Trial 4. Among the Poppies and No. 3, same way.

"Feeling less in both cases. Unpleasantness strongest just a little after beginning. Pleasantness best almost at the beginning. At shifts just vacancy. . . . "

Nov. 20, 1912.

Trial 1. Audrey Burton, and God Help the Poor Sailors. Speed 24. 60 seconds.

"Wasn't any sharp contrast. Girl more pleasant at beginning than afterwards. Didn't pay as much attention to the man. One only a picture, the other a scene, so effect not exactly comparable. Feeling for drunk picture sometimes humorous, sometimes indifferent. . . . General effect of girl at first glance pleasant. Details later not so good."

Nov. 27, 1912.

Trial 1. Elsie Ferguson and No. 41 (comic, wolf with hat, etc.) Speed 36. 60 seconds.

"Pleasant remained the same, while the unpleasant one grew worse. Transitions just blanks. At times pleasant one became indifferent, when attention wavered."

Trial 2. E.F. and white card, same way.

"Feeling-tone increased, intervals blanks. Brought up the image once in an interval . . . pleasant but faint."

Trial 3. No. 41. same way.

"Grew more unpleasant, feelings a relief. Both feelings stronger when alone."

In addition to the regular method, in which there was hardly any break between the exposures of the two pictures used, another method was developed from that of the check trials. Two pictures were used, in alternation, but with half the former exposure-time replaced by an interval, thus, a, interval, b, interval, etc. I hoped the results might prove more directly comparable with those of the check trials. The method was, however, so difficult, owing chiefly to the clumsiness of the apparatus, that it was used only at one speed. The main trials were at speed

10, and the checks at approximately double, 19+, so that a, interval, b, interval, etc., is to be compared with a, interval, a, interval, etc. It will therefore be sufficient to record materials and length of trial. The interval is always darkness.

Subject "J." Slight unpleasant tone

Nov. 7, 1912.

Trial 1. God Help the Poor Sailors, etc. 20 seconds.

" . . . Picture comical for a while, then feeling altered; went down below the normal unpleasant tone. Due to strain in watching, crooked lines, etc."

Trial 2. Hazel Troutman. 20 seconds.

" . . . Mildly pleasant tone, continuous, right through intervals and all. Began with a flash at very first of exposure. . . "

Trial 3. G.H. etc. and H.T. 20 seconds.

"Both distinct in their type, but both pleasant. H.T. very pleasant. G.H. a joke, not drunk but making believe. O. watching him.[16] Difference between the two feelings very distinct. Seem to arouse different complexes of organic sensation. G.H., standing off, head back, hands on hips, etc.; other quite different. *No breaks in either feeling, but a sinking in the curve.* Feeling for H.T. much the stronger. Quickening of mental activity during each exposure."

Subject "I"

Nov. 7, 1912.

Trial 1. Audrey Burton and G. H. etc. 40 seconds.

"During first few exposures the unpleasant picture showed a somewhat greater increase in intensity of impression. After it had reached a certain stage it suddenly seemed to become uninteresting and there followed a sudden shift to the pleasant face; the attention was thereafter almost completely centered here and the feeling-tone was increasingly more pleasant.

"Feeling-tone from ugly picture was not completely inhibited by presence of pleasant image with its accompanying feeling-tone, *but gave rise to a composite feeling-tone.* The agreeable feeling seemed more easily interrupted, and so far as its effect

[16] In taking down introspection it was occasionally put into the third person, or O. (observer) was used. *The subject's phraseology was not otherwise altered.* In some cases, especially those which involved mixed feelings, the subject was requested to write out his own introspection in full.

could be observed during the exposure of the disagreeable picture, it heightened the unpleasant effect."

Trial 2. Audrey Burton. 20 seconds.

"Seemed about seven exposures. During first four there seemed to be no persistence of feeling-tone during interval between exposures. Each new exposure, however, had a more immediate effect than preceding one. This was reinforced during last exposures by feeling-tone holding over. Interest was much higher at end than at beginning."

Trial 3. G.H. etc. 20 seconds.

"Seemed about eight exposures. Feeling-tone held over from very first exposure heightening effect of each succeeding one. Picture was beginning to lose interest on last exposure."

Subject "F"

Nov. 7, 1912. (Pretty well, but a little tired.)

Trial 1. Fly (magnified). 20 seconds.

"At first there was a disgust, shrinking, growing in intensity, first two exposures. Then curiosity came in; new attitude, feeling disappeared, became neutral, interest. Eye movements noticed; effort to make out object."

Trial 2. Eugen Ysaye. 20 seconds.

"At first dislike. Second exposure looked at name, then thought he was wasting time. Third, forehead looked good. Fourth, nose and hand good also; finally thought he wouldn't mind having him as a neighbor. Pleasant at end. Imagery agreeable now."

Trial 3. Ysaye and Fly. 40 seconds.

"Attitude towards fly belongs to the unpleasant side. No curiosity, no fine lines about it. Poor aesthetically, in marked contrast to lines of face. Pleasantness grew in other case, also interest. Two feelings divergent, with the pleasantness at a greater angle. . . . Transitions marked, like shoot-the-chutes. During intervals, expectancy always. Attitude preparatory, brought feeling for the comic picture."

Subject "L"

Nov. 8, 1912.

Trial 5. Hazel Troutman and Ancient. 60 seconds.

"Striking contrast, strong feeling. Repulsive, snarling feeling; crude, vulgar in every way. Other very pleasant, refined,

etc. Antithesis of tension and relaxation. Vulgar one, unpleasant tension; actress pleasant relaxation. Also a certain pleasant tension in case of actress and unpleasant relaxation in other. During first interval after unpleasant picture, the feeling was unpleasant. During all other intervals, the feeling was pleasant, concerned only with picture of actress. At beginning, feelings about equal. Pleasantness grew as trial went on, unpleasantness grew less and less."

Subject "M"

Nov. 8, 1912.

Trial 1. Hazel Troutman. 30 seconds.

"No feeling-tone at all."

Trial 2. Fly. 30 seconds.

"Disgusting all through, intervals and all, and grew worse as trial went on."

Trial 3. Hazel Troutman and Fly. 60 seconds.

"Likes H.T. fairly well. Other as disgusting as ever, perhaps a little more so. During intervals after fly, expectancy for other picture. Intervals after the girl not remembered. Pleasantness grew towards the end; no difference of degree noticed in the disgust."

With this contrast effect it will be of interest to compare the following trials. The method is the more general one, with an interval substituted for one of the pictures in the check trials.

Trial 7. Drawings, faces 1.a and 7 (artist unknown). Speed 19. 30 seconds.

"Both disagreeable, one less so than the other. Almost got on his nerves."

Trial 8. 1.a and white card. Speed 19. 30 seconds.

"Disagreeable, but not so much so as before."

Trial 9. 7, same way.

"As disgusting as he can conceive. Felt like closing his eyes."

"1.a. sketchy, clear-out, almost stony. 7, brutal." (*Cf.* Charles Rann Kennedy's, "John Heron goes and sits down on the keyboard of the piano. In the bass. *The cacophony relieves him.*" The Necessary Evil, p. 60.)

The method seems to have justified itself. Our results show considerable variety, ranging all the way from inhibition through partial and complete parallelism, with occasional fusion, to in-

crease in cases of contrast. Feeling may increase gradually, decrease gradually, change intensity suddenly, with a sort of staircase effect, or stay fairly constant for a considerable length of time. McDougall, in summarizing, for the purposes of his argument on the psychophysical problem, the laws of the behavior of feelings, says, "When several sensations of pleasurable tendency are present together, their tendencies re-enforce one another; and when sensations of opposed tendency are present together, the opposed tendencies partially or completely neutralize one another. Or, if the pleasurable feeling tendencies be regarded as of positive sign, and the disagreeable tendencies as of negative sign, we may express the facts by saying that the feeling-tendencies of the various sensations simultaneously present to consciousness are algebraically summed, and, according as the resultant is of positive or negative, the feeling-tone of consciousness is pleasurable or disagreeable, or in other words, the individual feels pleasure or displeasure. But the sensations are only one class of occasions of pleasure and displeasure. Every form of mental activity tends to affect the feeling-tone of consciousness positively or negatively, and the stronger or the more intense the activity, the stronger is its feeling tendency. In general terms it may be said that the smooth flow of mental process towards its proper end tends to pleasure; the baffling or hindering of it by any obstruction, conflict of tendencies, or difficulty of any kind, tends to displeasure. And of all such feeling-tendencies the law of algebraic summation holds good, perhaps not absolutely, but in the main and in general. The feeling-tone of consciousness at any moment is, then, the reaction of the subject as a whole upon all the many feeling-tendencies simultaneously influencing it."[17]

In view of the results we have quoted, it seems that such statements as the above hardly fit the facts. With simple sensations, the case may be different. We shall have to consider that, to some extent, later. With material appealing to what may be called instincts, the results are much more complex than

[17] "Body and Mind," p. 313. But *cf.* McDougall's "Introduction to Social Psychology," pp. 154-7.

has been generally realized. Simple algebraic summation seems to be unusual, rather than the general rule. We may leave our results to speak for themselves on this point.

As regards mixed feelings, the results seem to be positive, but we must admit that the experiences are decidedly complex, and somewhat difficult to introspect. The language used by the observers seems to indicate something different from that index of the general condition of the whole organism which is commonly spoken of. We have discovered certain possibilities in the behavior of feelings. There seems to be need of a more careful analysis of the feelings which do thus behave. Some attempt at this analysis was made in the next series of experiments.

A.3. As just indicated, the work of this section was the description, and at least a rough analysis, of the feelings brought out by the pictures. The introspection was not restricted entirely to the feelings, however. The subjects were asked, towards the close of the series, to report on the intellectual attitude towards the experience. They tended to do so from the first, and some of the results seemed so suggestive that I decided to make the best of the situation and see what could be gained. The results have, I think, justified this course, objectionable as it might seem to add to a task already difficult. In this case, the introspections throw a great deal of light on the problems of the relation of feeling to apperception, and the nature of apperception itself. Accordingly, I shall quote, for its general value, some introspection that does not bear directly upon our special problem.

In the earlier portion of this section, the check trials were conducted with the same method as in the previous section. Later, series of trials, using one picture with various others, were used. Two such series were used with all, or nearly all, the subjects. These will be given in full.

All trials in this section were at speed 24. i.e., the single exposures lasted 1¼ seconds.

First Series: To avoid repetition, the following abbreviations will be used. (a) stands for "There was a race back to Albion"

(a picture from a magazine), a man driving over a very rocky road, followed by another in the distance; and "Mrs. Aaron Ward Roses." (b) represents the first of the above and the drenched cat, "I am for Prohibition." (c) represents "a" (the garden with the path), and the roses of (a). The method was not the same for all subjects, but the changes were only slight, and will not interfere with comparison.

Subject "F"

Dec. 19, 1912. (Tired.)

(a) "The two feelings are quite distinct. Flowers, quietness, calmness, at-home-ness. Fellow lashing horses, puzzled, frustrated feeling, curiosity as to meaning of picture. Noticed many details of picture, hard, strained, stony feeling. Flowers a rest, decided relaxation."

(b) "The cat ridiculous. Solved the picture for him. The man was tight, and taking it out on his horses. All one general feeling of humor. The two mutually supported each other.

(c) "Fine; quiet restful feeling. Caught himself taking a long breath when the woodland scene came. Made out the roses. Couldn't have told what they were before. Now they are real roses. Is sure the woodland scene brought out the full realization of, and feeling for, the roses. (The team seemed to inhibit it. Before was a reserved calm; now full relaxation.")

Race to Albion and *a*

"They certainly did contradict each other; in direct opposition. Couldn't make out which was getting the upper hand. Feelings tended to neutralize each other. Not so strong this time. Runaway not nearly so roistering, so blustery, as when cat was there. Woods calm, peaceful, but not the distance, the far-away feeling that was there before. With the roses there was the feeling of Indian summer,—dreaming. That was taken out of it by the old man."

Subject "M"

Dec. 20, 1912.

(a) "One was agreeable, the other was funny. Neither very strong, just a little above indifference. Attitude not active. Pictures coming to meet him. Feelings continuous, two thin parallel lines."

(b) "Cat disagreeable. Other at first indifferent, then grew to be disagreeable. Feeling-tone of new picture seemed to be projected into the old one. Attitude towards the race picture now active. Felt as if he had something to do with it, and he didn't want to.

"Cat disagreeable from the first. Has an instinctive dislike for cats. Felt a desire to drive it away; wanted to strike it."

(c) "Liked both of them. The picture of the road was slightly more so. Felt himself walking along the road. Other more passive; more agreeable; feeling more pronounced than before.

"The two feelings were continuous, and partially fused."

"Was looking at the roses. More real, and nearer than before, but he was not active, just looking.

"Was walking along the road, and enjoying the scenery."

Subject "L"

Dec. 20, 1912.

(a) "Motor exhibition very interesting. Heard all the noise; could feel himself on the seat; liked it. Roses rather tame."

(b) "Cat more positively unpleasant than the other was interesting, wet cold, made her shudder a little. Wanted to read printing but it is reversed."

"Rose picture. . . . quieter, more a spectator."

(c) "Roses unpleasant; looked too much like specimens." Just a short exposure of both first, then roses, full exposure. Seems to lead to over-estimation of exposure of roses all through.

"Garden pleasant, more so than formerly. Seems to be due to the contrast effect."

"a" and I am for Prohibition.

"Cat is awful. "a" spoiled by it; seemed gray and uninteresting."

Subject "H"

Dec. 20, 1912. (Eyes tired; sleepy; didn't sleep well last night.)

(a) "Queer; didn't understand the picture of the man with the horses; occupied with the attempt to see what it was all about. Other picture did not hold attention. No feeling of pleasure; only curiosity."

(b) "Both very, very unpleasant; rivalled each other pretty

closely. Hated to see one coming, and then hated to see it go because the other was coming. Cat seemed to interpret the other. Whole thing was tipsy. Both bad as they could be."

(c) "Very pleasant, both equally pleasant; helped each other very much. Could get the odor of roses; could see them on bushes; made a scene of this picture somewhat like the other. Got the odor of the woods, too. Two experiences distinct though similar. The rose scene had a path too."

"a" and I am for Prohibition.

"Cat very unpleasant; increased as it went on. Other not as pleasant as when with roses but became more pleasant during trial. Unpleasantness the stronger."

Subject "I"

Dec. 19, 1912. (Went to a dance last night.)

(a) "Scarcely any development of feelings; seem to inhibit each other more thoroughly than any other he has had. Seemed as if there ought to be feelings, but they were cut off before they could develop. Almost a case of sensation without feelings. The incompleteness, inhibition, caused a sort of organic feeling, somewhat akin to the sort of strain in dreams when one tries to move and cannot.

"Roses were something pleasure-giving; but these seemed to lack reality of appeal; not fresh roses.

"Other very 'bill-board-y.'"

(c) "A good deal of reinforcement . . . the walk more prominent, suggests activity, very real. Seemed to prepare the way for roses.

"The first picture seen was the roses; same as before. . . but after the walk had come, they were helped in genuineness of appearance, got more dewy-looking. Walk picture gave a general attitude towards vegetation, which included the roses as well.

"Feelings for roses closely related to touch, something wearable.

"Walk very suggestive of all the agreeable feelings of outdoor life."

(b) "Cat is an awful looking creature.

"Other very, very rocky.

"Two more separate than the two pleasant.

"Cat unpleasant to touch.
"In other case purely a spectator, watching for a calamity.
"Each one stronger each time it appeared."

Subject "J"

Jan. 9, 1913.

(a) "First thing just a physical shock; reaction to sensation. (Race picture) Nothing made out. Then flowers . . . indifferent too. Both pictures practically indifferent most of the time, but once with each picture memories came in, and there was a momentary pleasure.
"Most of the time there was curiosity (attendant strain sensations), also organic sensations—feeling of going out towards pictures. Self-activity prominent at times."

(b) "Still puzzled about Race.
"Three attitudes towards cat: first surprise, amusing, characteristic organic reactions; then looked at cat's eyes, took the cat as a man who had been thrown into a mud puddle, amusement; then the cat was personified, saying, Look what you've done to me. Amusing again. Then it looked dirty. Wanted to kick it away; then wanted to wash it off. Unpleasant.
"Other still puzzling. More and more strain in connection with the desire to find out what it is."

Race, and God Help the Poor Sailors.
"The new one called up some of his old experiences in connection with the picture; empathy. . . . The fellow is not drunk, but just cutting up.
"Other just the same as before.
"Increasing strain, a sudden shock in head towards end, like striking of heels on sidewalk, etc.

(c) "Very strong curiosity in "Vorperiode." Seems to be localized in forehead.
"Roses came first. Rather mild liking; then *a* much stronger. Liked it because he could walk there and pick flowers, or with a lady friend.
"Then a sudden flood of consciousness of whole organism, with the thought that he was lying out there in the sunshine with nothing on; very definite pleasantness. The bunch of roses only secondary.
(During moments of strain, as in previous trials, the organic sensations noticed here disappear.")

Subject "K"

Dec. 18, 1912.
Trials 1 minute.
Race to Albion, and Man with Sargent Roses.

"Pictures seemed to be on different levels; one in garden static; other called up situation . . . being at a fair,—a little romantic. . . . Man unable to control his horses . . . no pronounced feeling, i.e. neither pleasant nor unpleasant."

Mrs. Aaron Ward Roses, and Man with Sargent Roses.

"Just at times the new flowers seemed real. Thought how fine it would be to smell them. Flowers by themselves better than the other. Man seems to have the flowers and O. is out of it."

(b) "Didn't like the cat, but not decidedly unpleasant. Other somewhat romantic. Liked to look at it, like being in some Western city or something of the sort; a little less pleasant than at first, because he is used to it."

Subject "C"

Jan. 8, 1913.

(a) "Enjoyed it very much. At first just wanted to know what was going on there. Thought those things were gardenias, then they turned to roses. Taken symbolically. Other not noticed at first, except it was a generally exciting affair; then taken as an elopement. This due to the roses; decidedly emotional experience, rapid breathing, etc."

(b) "Liked cat; reminded her of a time when she dumped an angora cat off a float. Other didn't get her attention. Most of the time was wondering what the letters were under the cat."

(c) "Very pleasant, much more so than before; taken in the same general way, but became serious this time.

"At first, path only an interval, very first time annoying; wanted to look at roses. Towards end was taken into association with roses.

"Felt herself breathing so hard there didn't seem to be half enough of her to breathe as deeply as she wanted to."

In the second series "The Lily Pool" was used throughout, alternating with six others, as follows: (a) No. 88 (a little

church on a hillside); (b) I am for Prohibition; (c) All I Did was Growl; (d) Sunset at Wood's Island; (e) The Garden Wall; (f) Brook in Middlesex Fells.

The length of each trial was 30 seconds.

Subject "F"

Jan. 9, 1913.

(a) "The two were immediately associated. The children were playing at the pool below the house. The house added to the beauty of the picture; gave protection, a homey feeling. House not aesthetic, but children decidedly so. One general attitude, parts of the same thing."

(b) "The pond-lily picture lacked the artistic finish, children were not as well groomed; pond not fit for them to play in; the cat had crawled out of it. Grew worse and worse.

"Not a story that he tried to make up. Just came with no effort. Tried to keep his former attitude, but couldn't. The two struggled, and the bad won."

(c) "They fit in fine. Hard to describe, but seemed appropriate. Dog belong to children. Pond with lilies . . . green leaves against their original beauty . . . etc. . . a beautiful scene.

"Not as with house. Then coziness, safety; now fitness. Mutually support each other aesthetically. Feelings parallel."

(d) "Didn't go together at all; two distinct fields. Couldn't pull them together if he wanted to. Feelings not parallel, but broken.

"Children not enjoyed so fully as before. Water picture cold, like northern scenery, ice, slush, etc."

(e) "Here there was a togetherness, a coherence not there before. Four children, two on the wall, looking down at the others. Children seemed to be gathering lilies with more zest because they were watched.

"One feeling—the two were simply parts of a whole, much closer than ever with the house."

(f) "Both pleasant, very pleasant, but they don't fit in together. Two distinct pictures, not so far apart as the "moonlight" scene and the children. Woods too wild for the children, though.

"Feelings not broken; run along parallel; both perfectly pleasant."

Subject "M"

Jan. 10, 1913.

(a) "Both agreeable, but different. The transition a shock; organic sensations, a little like beating of heart but not sure.

"Attitudes . . . children seemed to be related to him, and he was just standing and watching them play.

"House. . . . just seen as he was taking a walk in the early dawn . . . general haziness. House itself very insignificant. Situation as a whole pleasant.

"The two experiences entirely separate, remained the same throughout."

(b) "Cat picture positively disagreeable; other agreeable. In the same way. There was a sort of jerk at transition.

"Children's picture more agreeable this time than last time. Contrast seemed to cause this.

"Wanted to kill it (the cat). Attitude towards children same as before.

"General field of appeal is that of empathy; nearness prominent. Would like to carry the children on his shoulders. Nearness to cat offensive."

(c) "Children's picture very agreeable; dog not exactly agreeable; ridiculous or pitiable; shifted a little. Felt as if he would like to show the children that dog.

"No shock at transition; just as if he were turning his head a little.

"Feelings separate and broken."

(d) "Both were agreeable; a sort of jerk from one to the other.

"Children's picture more agreeable; growing more so.

(Sunset) . . . "seemed to be on the bank of the river; much like the river in his native village.

"Two experiences wholly unrelated."

(e) "Both agreeable; just one feeling; no break at all. Difference only in that the new children are strangers not related to him, but he likes them.

"No transition shock at all."

(f) "Both agreeable, but there was a distinct transition, and in a way there was a sort of contrast.

"Wood,—walking alone . . . a sort of poetical loneliness. The children were with him, good company."

Subject "L"

Jan. 10, 1913.

(a) "Breathes in with the Lily Pool and out with the church. Lily Pool seems to demand expansion; reverse with the church. Like looking into the two ends of a funnel. Church interesting, but there is no life in it, no motor interest. . . . "

(b) "Rather shocked to see the cat again.
"Breathing effect reversed, but it was too fast for her this time.
"Just a very short exposure of kitten, disturbed her a good deal.
"Getting tired of children . . . familiarity. Whole experience a chilly one."

(c) "Breathing in with the Pool and out with the puppy; brought back the feeling she had when she came in.
"Children seemed to be in a class with the puppy.
"General warmth in whole experience."

(d) "Sunset reminded her of an experience in the Golden Gate, interesting. Other just an unpleasant interruption; took her time from the new one."

(e) "The Garden Wall unpleasant because the child's legs look too long and stretched out.
"Old one pleasant."

(f) "Auditory image of stream. Could feel the woods.
"Likes the Pool better this time. Liked the idea of life. Woods a little subtle and uncanny."

Subject "H"

Jan. 17, 1913.

(a) "Lily Pool familiar and tiresome. Other a decided relief, pleasant each time it came; exposures seemed longer than of children.
"House interesting; a sort of entering into the atmosphere of the place; felt the coolness, imagined the family, etc.
"Other annoying, irritating."

(b) "The children became very pleasant. Rather felt that the interest was forced by the contrast; no imagery or associations.
"Cat annoying, unpleasant to look at.
"Delighted when the trial stopped."
"Pictures didn't seem to enter her consciousness; just things she had to look at."

(c) "Dog pleasanter than children; sort of quaint humor about it; seemed to put herself in the position of the dog and feel that the mask was too much punishment for a little growl.
"Children just very slightly on the favorable side; not real, but mere figures. Likes the overhanging tree.
"Transition neutral.
"Pleasure in dog a continuous feeling, only weakened a little when children were there. Children gave a slight boredom, which did not hold over."

(d) "Water very, very pleasant. Children remained neutral; their exposure seemed very much shorter.
"Water scene a beautiful picture; not just a picture, a real view."

(e) "Made all the children real, i.e. just beyond the border, wouldn't have expected them to speak. Seemed to be the same two children, in spite of the difference in color of hair. Wouldn't have cared enough about them to speak to them.
"New picture seemed to redeem the older one. Whole experience very slightly pleasant. Wouldn't care to repeat it."

(f) "Interesting. Children first . . . bored feeling.
"Stream very pleasant; auditory imagery, water rippling over the stones.
"The transition from stream to children was filled with imagery of the other water scene; almost wiped out picture of children. Didn't notice them at all, just conscious that they were shown.
"Picture of children leaves very little impression; has had to stop and think each time to realize that the pool was shown."

Subject "I"

Jan. 16, 1913.

(a) "Accentuated each other to a very marked degree, feeling-tone grew almost continually more pleasant. Quite distinct, no fusion. Difference in light seemed to relieve the eyes. Very restful to get to the church; very interesting to go back to the girls.
"Entered more actively into experience with the church; walking down the slope.
"Other independent of him, but attractive."

(b) "Cat unpleasant, seemed to spoil color of pool. Green not so saturated. Unpleasant feeling held over. Half way through, comic aspect of cat came up and made him laugh. After that, seemed to pay a different kind of attention to the pool; colors seemed to be truer. Seems queer, but there does seem to be a difference in the objective appearance in the two parts of trial.

"Feeling, alternation of nausea and well-being."

(c) "Aided each other rather than interfered. Two appropriate to each other. Didn't go as far as actual ownership of dog by children, but they went together well.

"Passive observation of pool. Dog taken actively. Thought of patting him, tumbling him round, and maybe taking the mask off him.

"Both pleasant. Seemed to be something carried over from one to the other. A general feeling of internal comfort. In addition there were elements peculiar to each picture; one aesthetic, other social."

(d) "Pretty hard to find himself, to settle down to any definite state of mind.

"Children first, same as before.

"Other picture altogether different, seemed dangerous. For a while it shut out the pleasure in pool. Latter just marking time, while he was trying to look at water scene and understand what it was. After he decided that it was only cloudy weather and not really dangerous both were slightly pleasant, but totally incompatible.

"An effort to get any setting for boat picture, unstable . . . outing, practical utility.

"Other constant, rich with color and meaning.

"Seemed to try to hit a mean that would suffice for both, but couldn't quite make it. Was straining to look at the children, when this is not needed, and when looking at other picture, there seemed to be traces of his attitude to pool. Imagery did not hold over."

(e) "About as nearly like a single picture as could be.

"Feeling-tone augmented.

"Stronger lighting makes pool a little more real. Pool is the halting place. Children on fence are on their way to the pool. Sort of a story,—not four children, but two. Pool the prominent one for feeling. Aside from this the feeling was just one throughout."

(f) "Rather a curious effect, two feelings in connection with brook. Transition from color to lack of it essentially unpleasant. At the same time, the appeal to general organism was very pleasant. Called out a feeling of its own.

"Other a bit monotonous, but noticed the childlike character of the hands of child holding flower. Coloring also pleasant.

"Two pictures distinct in feeling, call forth different attitudes. Pool passive, other active."

Subject "J"

(a) "Both pictures very pleasant, but completely separate. Towards end, thought, if they are both pleasant, why in the dickens don't they run together. Then they did with a sort of shock.

Church picture . . . associations . . . touched off erotic complexes . . . social experiences.

"Lily Pool did not call up such associations until towards end.

"A good deal of empathy. Varied between objective and subjective.

"Organic sensations . . . in throat and upper chest, connected with panting, etc., i.e. those organs. Attention very lively; passive all the time."

(b) "An entirely different experience. Was expecting something he had never seen before. There was a shock of recognition, "Oh, it's you". . . . Cat indifferent so far as pleasantness-unpleasantness was concerned. Next time it came, was a little amusing. Seemed to take away from the other at first. Later the pool became dominant, but not so strong as before. At the very end, attitude of "clever(?)" practical joker came in. Was setting the cat on the middle of the pool. Possibly due to his disappointment at the cat. Fiendish delight in tormenting the little girls by putting the cat there.

"Trial cut off before the experience had completely developed."

(c) "More like the first one in the amount of association called up. Girls and pool getting more or less indifferent.

"Other came as something entirely new. Thought in-

stantly as the dog of the girls, but he seemed too forlorn. Separate for a while. Then the thought came that he was inside, and they were out. A certain sympathy because he is muzzled; no tendency to help him.

"Feeling-tones of the whole thing rather indifferent, but border on pleasantness. (But the rough skin of the dog's hindfoot looked like a rhinocerus's hide . . . a certain slight horror, no organic reaction).

"Organic sensation not focal during the experience."

(d) "Girls first, full exposure, seemed unusually long, mildly pleasant.

"Wondered what the next was going to be. When it came, more or less of an organic shock going downwards in his body, . . . pleasant.

"Pleasure lasted all through.

"Associations came rather slowly. None for the pool. Other . . (1) out boating, (2) an early morning on the Elbe.

"Whole experience very sluggish."

(e) "New picture came first. Brought a very pleasant feeling-tone instantly. At the same time there came a thought of the other picture, with some imagery, not completely. Thought the whole experience was going to be girls. At first a little distinct. Then girls on wall were looking down at the other. But a few incongruities; no fence in pool picture. Girls on wall a little too high to see in the other.

"Two thought together all the time. Looking at one with the other at the background. Then the reverse.

"Association widened in scope. Children in general; the children in the streets of Berlin; then some young relatives of his, etc."

(f) "New one came first. Relaxation (organic sensations in chest). Associations of experience in woods.

"Other brought back association of first trial. Basin in botanical garden.

'Feeling-tone of pictures runs together, very pleasant. The prominent thing was the feeling-tone. Pictures intellectually distinct."

Subject "K"

Jan. 17, 1913.

(Rather sleepy, hasn't been up long; not thoroughly awake yet).

(a) "Likes both of them slightly. Difficulty in making out church scene, because lighting is not so bright.
"Both pictures remote. . . . "

(b) "Cat unpleasant, aversion, just slight. Other slightly pleasant,—light, brightness, coloring, summer, etc. No special interest in the children."

(c) Seemed to associate the two pictures. Really one to him. Dog in one corner looking at children in the other. Playfully sullen.
"Somewhat pleasant. Seemed nearer than before. No break at transition."

(d) "New one the pleasanter. Seemed to be sometimes transposed to the scene and watching it; could see all the surroundings. Could localize the picture of children too, playing on a little hill.
"Transition a gap."

(e) "These two are connected too. Two children on fence are looking down at others. Liked the ones on the fence better, because he could see their facial expression.
"Not localized in space; only saw the picture.
"Both pictures slightly pleasant. Just the same except that those on fence are more "active." They are watching the others, taking it all in. He likes them better."

(f) "New one seemed to be in the evening; other morning or afternoon. "Road" pleasanter when it got him into the mood of being alone. Other getting to be pretty commonplace, indifferent."

The above results seem to point to a very close relation between the feelings and what are commonly called intellectual processes. The mutual influence of the feelings depends largely upon the similarity of the presentations, i.e. similiarity in meaning, in appeal. When the two feelings are of like intensity, if the total reactions are widely dissimilar, the result is inhibition. Inhibition diminishes with increasing similarity, until in some cases, there is a tendency to parallelism, and rarely, fusion.

When the fields of appeal become nearly identical, the feelings either become one, or increase by contrast, in alternation, according as they are of like or opposite value. When the feelings are of unequal intensity, inhibition continues farther up the scale of similarity. Further, there are individual differences, which seem to be related to the scope of attention. The above statements represent the hypothesis which resulted from all the work so far. The remainder of the investigation is an attempt to test its validity.

A 4. In this section the tasks of the two previous were combined; the subjects were asked to trace the course of the feelings and describe them as well. The speed ranged from 10 to 72, the same pictures being used in series of trials at various speeds. The first two series began with the lowest speed, i.e. the longest exposures, while the later series started from the opposite direction. Excepting a few odd trials towards the close of the season, the work was the same for all the subjects. The check method of the preceding section was adopted, a pleasant picture being used with another pleasant one and with an unpleasant one, etc., while some series were concerned with other pairs of opposites, such as excitement and calm. The materials were entirely new, so that familiarity is not a disturbing factor. A brief summary of the results with several series will be given with such examples of the introspection as seem important.

In the first series only two pictures were used: (1), a crude 'comic' entitled Who Moved That Keyhole, being an intoxicated man in evening dress with battered hat, trying to unlock a door; (2), a little boy in red jacket and cap, from Nordmark. The speeds used were 10, 12, 14, 16, 17, 19, 23, 24, 29 and 36, in the order stated. The length of the first trial was thirty seconds, of the rest, twenty.

Subject "L" found 'neither picture very striking.' They began on the 'same level of interest,' and 'blended very easily.' The 'man excited curiosity more than the little boy.' (Speed 10). The 'man is just dressed up for the occasion.' (Speed 12). As speed of exposure is increased, 'motor effect comes in more,' . . . 'feels more as if she were the people.' 'Man's hand

getting tiresome, felt as if she were holding the key.' (Speed 16). All feeling except interest in experiment disappeared after Speed 17. At that speed, there was 'much more interest in the little boy.' Speed 12 seemed slower than 10, and 14 the same as 12. A change is noticed with 16 and again with 17.

"J" found the man 'less real,' 'tendency to comic'—'not a real drunk, but a man acting.' The boy is serious. 'Pictures do not interest at all. Feeling-tone not noticeable after first exposures; no fusion.' (10). The interest in the pictures increased, they seemed brighter, and 'the whole experience more active and vital' with increase of speed. (19). At (23) the pictures ran together; he 'saw the little boy standing laughing at the man.' 'Mildly pleasant throughout.' This unification disappeared and the pictures became indifferent at the highest speeds.

With "C" and "H" there was a good deal of feeling, chiefly displeasure. With "C" the maximum is at (19), the pleasure being completely inhibited then. There is no feeling at (36). With "H", the highest point is at (23), and at (36) it is still 'very unpleasant. Haven't reached the point of tolerance. Still struggling against it.' "H" did not notice the difference in speed until (36).

With "K" the two were well contrasted at first, opposed morally, 'about equally balanced,' 'feelings distinct.' The contempt for the man was stronger at (14) and (16), and the boy 'not so pleasant as he might be, ... pampered and overfed,' 'being spoiled and might get where the other is.' At (19) and the higher speeds, the two were put together into a situation, and the 'slight antipathy for the kid is gone.' The feeling is practically nil after (23).

"F" found that the pictures 'opposed each other, no fusion, radically apart.' 'Man the dominant picture.' (10). At (16) the 'man has a sort of impudent look, the little boy looks more friendly. (Before, he looked shy.) They seem not so far apart—in same neighborhood. (Before, they were far apart). Think it is due to speed.' Then the man became humorous (17), and finally 'stagey.' 'Is really tipsy, but it is partly put on.' The boy gets more human and real, and becomes the dominant picture. The spatial relation disappears. The pleasure increases and inhibits the displeasure completely.

With "I" the feelings were at first slight (10), then increased, 'more contrast' (12); then he seemed to interpret the two as phases of a single thing (14). The interpretation held throughout the rest of the series. The pleasure was dominant at (14) and (16), then gradually gave way, until the displeasure came to be dominant at (36). The feelings alternated completely.

The general effect of the shortening of the single exposures is increased inhibition, as might be expected. The tendency to assimilation in meaning and to a synthesis of the two presentations is, I think, worth following up. It reappears constantly.

In Series II, a picture of a road through a pine grove at Concord was used, first with the rear view of the Paul Revere house, and then with a picture of a path in the New England Gardens. The trials lasted 45 seconds each, and were made with speeds 10, 23 and 36.

"K" found all three pleasant, the trees less so when alternating with house than with flowers. The feeling diminished with the increase of speed, but was not inhibited entirely. Speed (10) was the best.

"F" found the first trial 'a numbing experience,' could hardly say anything afterward. 'Neither attractive.' In the same trial, the 'trees were not at all as before.' 'Would hardly believe the woods scene was the same picture. Two not parts of same scene, or anything of that sort, but similarity helped. A quickening, exciting experience.' The feelings increased in the trials at higher speed. 'More active interest.'

"L" found the house 'close, stuffy,' the trees 'cool and green.' There 'seemed to be a difference in the air she was breathing.' The flowers were 'a great success,' the 'trees gray and uninteresting in comparison, not so pleasant as before.' At (23) the feelings are less marked, and at (36), could see the pictures all right, but not time for feeling to develop.'

With "H" the 'walk between the trees' was 'a great relief every time.' . . . 'Glad to get away from the house.' The flowers were 'a pleasant surprise, afraid she would dislike the lane, but there was a peacefulness and restfulness about it that was charming.' At (23), the lane is less effective in both cases, while at (36) the pleasure in the lane was completely inhibited by the unpleasantness of the house, while the trees gained the day over the flowers. In each case the dominant picture seemed to be exposed very much longer.

"C" 's results have to be discarded on account of the influence of associations.

"J" 's results in the first trials are almost exactly the same as those of "F". The feeling was less at the higher speeds, trial 5 being indifferent, and trial 6 mildly pleasant.

"I" 's introspection will be given in full:

Speed 10. 1.

"Quite a strong contrast. Ugly one looked uglier each time. Not sure that other one was improved, because of the alternation's being unpleasant. Pleasant, but there was unpleasant anticipation of the other.

"After about six exposures of house, felt like doing something, demolishing house, or clamoring out against having to look at it.

"Feelings during exposure of woods mixed—pleasant, but worried. Two parallel, not alternating.

"While looking at ugly picture, his feeling was for that alone."

2.

"Fine. They reinforced each other a great deal. Easy to imagine them parts of one scene. Just one pleasant feeling increasing throughout."

Speed 23. 1.

"A queer thing happened. Woods picture seemed to hold there for quite a while once, yet the other picture was much more present to his mind. And in the duration of the woods picture was just using it as a sort of brace to help him ward off the other. Same mixed feeling with the unpleasant anticipation the more prominent factor."

2.

"General effect just the same as before; just one feeling all through, nearly apprehended as one picture. . . . "

Speed 36. 1.

"In order to get anything out of it has to concentrate on the house; woods almost a blank. Still succeeded in giving the house some meaning, but not very vivid. Rather unpleasant, but not so much as before. Woods indifferent."

2.

"Got a clear interpretation of it all the time; kept its feeling-tone pretty well. Seemed to be riding through at high speed. Woods altogether different from in (36).1."

The familiarity gained during the early exposures, when these are at low speed, seemed to influence sometimes the results at high speed. Hence the rest of the series in this section were taken in the opposite order. This method brings out the selective and assimilative features of the apperceptive process still more clearly.

Series III will be given complete.[18] (a) represents speed 36; (b), 29; (c), 24; (d), 16.

In trials-1, an old lady with her knitting, from Leksand, was used in alternation with a frightful 'comic,' a caricature of an old woman, with a dog, the latter being humorous. In trials-2, Luise von Preussen was substituted for the caricature. Subject "K"'s results are dropped, owing to a mistake in the order of trials. The length of each trial was 30 seconds.

Subject "L"

Feb. 28, 1913.

a-1. "Faces stood out strongly. 'Old woman' etc. worse than the other was good. Other had a slightly vicious expression . . . a little cross-eyed, etc. A motor response; wanted to do something about it, but doesn't know what."

a-2. "That was the niece or granddaughter of the other. Old lady looking at her,—more intellectually alert than the girl. Girl rather pathetic,—but more a symbol than a living object. Old lady was living—much better than in (1), more human, didn't have the witch-like cackle you might have expected before.

b-1. "Leksand old lady looking worse again; back to her

[18] The task of the present section was so difficult that the subjects, even those of long experience tended largely towards objective description instead of strict analysis in subjective terms. They described the pictures instead of their own feelings. However, in view of the interesting way in which these descriptions vary with the method of exposure, it seemed best to allow the statements to be made in the more natural form, rather than to run the risk of falsifying the results, or getting none at all by strict insistence upon the technical form of report. The variations in the descriptions may be interpreted as indicating changes in the response of the subject, with some risk of error, it must be admitted. Mere verbal associations may creep into the objective statements and it may be difficult to sift them out from the genuine response objectified.* Still, with all due respect for laboratory tradition, I feel that in such a case as the present, where the facts of inhibition, parallelism, etc., and not the analysis of the single feelings, are the object of investigation, it is wiser not to insist upon one form of statement rather than another, but to put as much stress as possible upon accuracy of the statements made. Some introspections which cannot be wholly justified even by the above views have been included in order to keep the series complete.

* *Cf.* Santayana, "The Sense of Beauty."

original condition; also too idle; ought to be tending to her work. The other creature was making more noise this time, worse than before. (Two entirely separate.)

b-2 "Leksand old lady back to her pleasant expression again. Young woman improving. Feelings separate—transition."

c-1. "The frantic specimen has turned into an object of abnormal psychology. Heard the dog saying, "My dear woman, you're making a great mistake." Better than before, not unpleasant.

"Other old lady just a placid spectator of specimen; lacks initiative."

c-2 "Take on now a more special attitude. Old lady Swedish, girl German type. Both very pleasant."

d-1 "Leksand . . . had a dish-cloth about her neck; stripes in dress noticed. Doesn't vary in pleasantness from before.

"In other, dog gained in vivacity. Specimen just the same as before."

d-2 "Doesn't like either of them, Too immobile."

Subject "F"

Feb. 28, 1913.

a-1 "Good-natured, motherly woman seemed to be exposed much longer. Attracted to her; shrank from the other. Both faces grew in distinctness and clearness as trial went on. Appreciation increased too. Kindly feeling towards good-natured woman. She grew more so as trial went on, while the cross one grew crosser, so the two seemed to be farther apart at end.

"Feelings entirely distinct. Strain at transition, a sort of screwing up of face."

a-2 "Thought the old lady was clear before, but this time much clearer; clothing brilliant; figures stood out. Young lady very pretty. Two mutually supported each other. His social attitude towards them is a good deal the same. Did not associate them personally.

"No strain at transition.

"In (1) the old lady seemed to want to make the best of everything. In (2), she was just bubbling over with good nature; was really good in herself."

b-1 "Pictures farther apart. Strain is greater. Both clearer, but good-looking old lady more so. Details of her dress come out more. Feelings stronger this time. Good old lady seems to be wanting people to overlook the weakness of others, to make the best of things. O. wanted to ignore the bad picture. She seemed farther away this time."

b-2 "The old lady is more brilliant, vivid now, as if a spot-light were turned on her. Before she was more prominent than young lady, but now the emphasis of attention goes to the young lady

"Relaxation instead of strain as in (1).

"More pleasant than in a-2, a greater contentment."

c-1. " 'That old witch and I had it out that time.' She was the more prominent in consciousness. A kind of a cussed feeling about her. Made out the dog this time. First time he has seen him."

c-2. "Old woman a little tense and anxious in comparison with the calm composure of the young lady. Both pleasant, but there is this difference. One a little tense, other relaxation. Does not think of old lady as so benevolent now."

d-1 "Wise old dog has come to his rescue again. Old lady no better, but he doesn't take her so seriously. Longer time gives him a chance to grasp them more fully. Attitude seems much more complex than before. Other old lady still a pleasant relief, but the emphasis is upon the bad one. Still entirely distinct."

d-2 "The young woman is more beautiful. Set of head and the graceful lines come in more.

"Old lady looks more foxy. A little glint in her left eye. Her character hurt a little."

a-1"Not the same as the first time, but the Leksand woman is a relief from the other; a strong personality; does not take her as so good as before. But the emphasis of attention goes to her again."

a-2 "More as pictures; not so real as at lower speed. (As speed decreased, he began to feel acquainted with them). Doesn't feel as if he knew them so well. Old lady still a little crafty."

Subject "H"

Mar. 4, 1913.

a-1 "Very nice. Trial about half through before she noticed the unpleasant one,—and it didn't come in other much. Seemed a very short exposure."

a-2 "Granny lost by comparison. Likes the girl better,—a darker picture. Both pleasant."

b-1 "Very nice. Unpleasant one not unbearable because it helps to make the other pleasant. Old lady very charming just as at first. Exposures seemed equal."

b-2 "About the same as a-2. Girl pleasant; old lady less so (than with other specimen).

"Difference in speed does not seem to make any difference in feeling."

c-1 "A little less pleasant than before. Unpleasant picture seems to occupy three-fourths of the time, and the unpleasantness seems to lessen the pleasure in the old lady."

c-2 "Doesn't respond to the old lady's smile now. Girl pleasant, cool and calm, slightly unresponsive, but she likes that."

d-1 "The next step in the same direction. Unpleasant exposure longer; takes away from the pleasantness of the other. Not *positively* unpleasant."

d-2 "A distinct pleasure each time the girl comes. Old lady much less pleasant. Once she thought the girl was exposed longer."

Subject "C"

Mar. 12, 1913. Sleepy.

a-1 "Hurt her eyes so much she had to stop."

a-2 "Too fast to get any feeling, but she did look for the whole 30 seconds."

"Luise self-satisfied looking."

b-1 "Just mildly bored. Hurts her eyes; feels cross-eyed at every shift."

b-2 "Sure the old lady hasn't any teeth, and the other lady looks flat; and she isn't a bit surprised by either of them."

c-1 "Rather a boring experience. Very slight feelings. Pleasant and unpleasant alternating."

c-2. "Pleasant one in the dark. Old lady still lacks teeth."

d-2. "Pictures in other positions. Both much better, old lady not so sharp; girl better.

"Trial seemed very short, not more than a quarter as long as the others."

d-1 "Pictures reversed. Caricature not real to her at all. Old lady just a normal old lady, mildly pleasant, not so much so as with girl. Not interesting, but her attention is on old lady, not on caricature."

Subject "J"

Mar. 6, 1913.

a-1 "First time he saw the witch, just recognition. Other old lady slightly pleasant. Next thought of Shakespeare's Macbeth, but said, the witch of Endor. Noticed her feet, then noticed old lady's glasses, didn't like them. Both real. Old lady (sewing) venerated for her character, etc. Then attention shifted from the pictures themselves to the effort in seeing."

a-2 "Both continuously pleasant. Practically fused. Parts of one situation. Old lady looking at the damsel. Strong organic reaction. A sort of anticipation of the shifting, no effort. Imagery carried through as well as feeling."

b-1 "That time those two pictures fused. Old witch had come to try and hypnotize old lady. A very amusing situation."

b-2 "Young lady very pleasant. Thought of her as a real leader, a genius. Two pictures separated now. Old lady just off to one side,—indifferent. When she came, was thought of in the situation of b-1."

c-1 "Discovered the dog this time. Couldn't make him out before. Amusing. Old lady knitting; didn't know that before. Experience indifferent except for dog. Didn't think of a single thing outside the pictures. Quite real."

c-2 "Rather a mixed-up affair. Both of the previous situations tried to get back, but did not succeed. Pictures taken separately. Associations came in. Young lady still slightly pleasant; old lady indifferent. Young lady not so well balanced as before. Thought of a story he had read. This girl taken as an American who had married a German."

d-1 "Everything except the dog absolutely indifferent. Same situation as before. Dog is an on-looker enjoying the situation. Empathy. Old lady is getting nothing done. Wants to see her do something."

d-2 "Brightly lighted old lady butts in. Adjustment rather painful.

"Young lady pleasant, still real. Not thought of as a picture.

"Old lady herself indifferent. Bright light unpleasant. No carrying over of pleasantness. Has to begin again each time. Absolutely no anticipation."

Subject "I"

Mar. 20, 1913.

a-1 "Distinctly grew in disagreeableness from beginning to end. The worse was so bad that the other hardly came in at all; so bad that it held over and was anticipated. Stronger reaction to it every time. Unreal, but horrible, like waking up from nightmare. Fascinated, yet repelled."

a-2 "Pretty girl preponderated, but the old lady was an annoyance. As if he were looking right at her without really seeing her, but not so much as he would have liked. No illusion about time. Feeling-tone ran in two layers. Girl distinctly pleasant, but there was an undercurrent of annoyance. Relative strength of impression about $2\frac{1}{2}$ to 1. Before about 5 to 1.

b-1. "6 or 7 to 1 this time. More reality about old woman; not a mere piece of pasteboard, more alive, an unfortunate creature. Doesn't think he saw the other more than twice. A little pity comes in this time. Can be taken as a fact, not a fancy now."

b-2 "3 to 1 this time. Noticed a little impatient catching of his breath when the unpleasant one was there. Noticed that he started focusing eyes for the pleasant one while other was still there. Once . . . seemed to hold too long. Due to his focusing too soon for the good one.

"Feelings parallel again all the time. Wavered in strength, but never broken. A sort of lemonade effect, the sour and the sweet."

c-1 "Getting angry with the woman. Dog came in more, silly, rather pleasant. Made him laugh. About 8 to 1 in strength. Unreal again towards end. No time illusions."

c-2. "Unpleasant one a little stronger again. Stronger desire than ever before to shut her out. Wanted to shut his eyes. Girl quite attractive; enjoyed her more and more to the very end. Afterwards his memory brings up the unpleasant one. Unpleasant one is associated with the other awful one. Fairly ground into him.

"Feelings more fused this time. Bitter-sweet with alternating emphasis. Never a complete absence of either. Almost equal."

Series IV was undertaken in order to test the effect of excitement and calm, for comparison with the results with pleasure and displeasure. This series also will be given in full.

In trials-1, the pictures are Riksdagshuset (a parade, with a large building in the background), and the court-yard of the Boston Public Library. In trials-2, a view of a portico at New England Gardens takes the place of the parade. The speeds are: (a) 36; (b) 29; (c) 24; (d) 23.

Subject "L"

Mar. 7, 1913.

a-1 "Too fast; couldn't get any ideas before it was gone . . . with each. One looked like B. P. L. Other rattled her. Unsettled, uneasy. Pictures indifferent."

a-2 "Both pleasant. New one much more so. Feeling of repose, quiet; helped by buzz of machine. B. P. L. a little too stiff. Nearer apperception time in this trial."

b-1 "Parade one associated with inauguration; very attractive, sunlight. Other moldy in comparison. Parade seemed German; pleasant. Just shut her senses to B. P. L. B. P. L. shorter exposures than other.

"Feels much more comfortable; breathing slower and easier."

b-2 "Still too fast for comfort. Worse than b-1. Feels choked. Pictures pleasant. Garden one more so."

c-1 "Very much more comfortable.

"Emphasis is on the parade; French or German. Other just fills in time; not positively pleasant."

c-2 "Garden gaining in pleasantness; other losing."

d-1 "Got into rhythm of motor. Took away a little of her feeling for pictures.

"Gaining interest in library again, i.e. relatively. Other lost."

d-2 "Heard water splash. Added interest. Both gaining a trifle in pleasantness on that account.

"Transition is more easy in (2) than (1)."

Subject "F"

Mar 7, 1913.

a-1 "Incongruity between the two pictures; and fellows marching spoil the picture. Uniforms look black. At this speed they hardly look like human beings. Irregular, jerky, in contrast to lines of the buildings. (Procession came first, then "mansion.") Wanted to get rid of band."

a-2. "So beautiful he can't describe it. Affected his breathing. Felt as if he wanted to say something, but didn't know what to say. The two mutually strengthened each other. (B. P. L.) a little dim. Wanted it to be as well lighted as the other. Both beautiful."

b-1. "Other speed was too fast. This helps the parade. The men seemed to be really marching this time. The beautiful picture was not so dim. Both improved."

b-2. "Seems to understand the (B. P. L.) picture; seemed to be an inner court; seemed to be the Jefferson Hotel in Richmond. Pleasanter because he appreciated it better. Other not surprising of course, but beautiful. Had more opportunity to grasp details."

c-1. "Couldn't see much change. More empathy for the marching.

"(B. P. L. is a different building; a government building of some sort.") (Association).

c-2. "Both hotels this time. Gets more details now. Noticed the pottery this time and the pond of lilies, fountain in inner court, etc. Both pleasant. Just as beautiful as before."

d-1. Didn't enjoy the soldiers marching so much. Other, if anything, more beautiful. Noticed lines of columns, etc. No response to rhythm.

"Both government buildings."

d-2. "Both again in detail and in appreciation. Both hotels. Enjoyed more than before. Two are more on a level. (B. P. L.) not so dim, but imposing. It will wear well, not get tiresome.

"Transition in (1) very abrupt; in (2) hardly noticeable."

Subject "J"

Mar. 13, 1913.

a-1. "First mood called up—Berlin—wouldn't quite fit in. Other B. P. L. But two were taken together. Grandeur of archi-

tecture in B. P. L. harmonizing with order of soldiers. Speed a little too great for satisfaction."

a-2. "Mood of same quality as before, but more pleasant. Both fused into one whole, just passing from one part to another. Satisfied pleasure. B. P. L. a little barren in contrast with other. Changing didn't seem so rapid as in a-1; could catch details more clearly."

b-1. "Trying to get details, but each time the other comes flip. Dissatisfaction with each picture. Got no feeling tone for either picture itself. Experience as a whole . . . effort to get details the prominent thing."

b-2. Mildly pleasant both of them; courts of the same building or something of that sort. A slight preference for the more complex one."

c-1. "A German scene and B. P. L. Mildly pleasant . . . inactive. Scenes real. Separate now. Can't recognize the building, but takes it as in Berlin. Speed more satisfactory; going slower. Pleasure aesthetic."

c-2. "Mildly pleasant, both of them. Not the library now. Two are parts of same palace. Thought how nice it would be to walk along by the water. Pleasure erratic. Organic reactions. Remembers looking at flowers, grass, water, etc. Bust started associations, one of the museums in Paris."

d-1. "B. P. L. again. Mood of public building. Mild admiration for architecture. He is a spectator. No immediate connection, i.e. local. They are both public places. No contrast in mood; no associations."

d-2. "Four distinct moods, perhaps 5. 1st library; wouldn't work. 2, a palace kept up for show. 3, Palace one in which old-time kings live. 4, Modern palace, modern kings living there. 5, His own house. Mild erotic feeling; increased towards end. Two pictures fused throughout."

Subject "H"

Mar. 18, 1913.

a-1. "Very pleasant . . . watch in Berlin? . . . enjoyed it very much. Other pleasant too. Reminded her of the B. P. L., but not sure. (Asked me; I told her.) Liked speed; seemed to be doing things."

a-2. "Too fast for the new picture; couldn't get anything out

of it. Library still dignified and cool, but the two little awnings were very bad."

b-1. "Speed unpleasant; made her dizzy. The marching. . . . They were getting too close. Library all right. But men are more real than before. Going too fast; wanted to look at them longer."

b-2. "Doesn't like the shifting. Feels familiar with the library, . . . but wants to see the other, can't wait. Library seems to be exposed ever so much the longer."

c-1 "Soldiers going to the band concert in the square, very pleasant. Didn't see the library at all; actually didn't know it was there."

c-2. "Didn't see the library this time either, although she had intended to look at it. (Gardens) very pleasant now."

d-1. "Noticed the jars in the library picture. Otherwise it was all the "Berlin" picture. Very pleasant associations. They come in more now,—people that she knew, etc."

d-2. "Library much the longer time. Noticed a lot of details. Mildly pleasant, but not interesting. Wanted the other. Other not there long enough."

Subject "C"

Mar. 19, 1913.

a-1. "Too speedy. Doesn't like it all. Hurts her eyes. Knows what the pictures are, but that's all."

a-2. "Very pretty pictures. Liked to look at them, but towards end, eyes got cross-eyed and hurt again."

b-1. "Liked the garden one, but the people came in too much of a hurry. Contrast favors (B. P. L.)."

b-2. "Very pleasant; go well together, but (B. P. L.) is lots better, dignified. Other ostentatious."

c-1. "Likes the nice, calm, placid one. Other distresses her. Doesn't like to see them hurrying. (Empathy.)"

c-2. ""Thinks she is turning socialist. Wants to smash the statue in (Gardens).. Much more concerned with the pleasant. Both feelings alternated. +>—"

d-1. "Heard the band; wanted to be there. Other just losing. Lots of things finer than just satisfying one's senses. Wanted to be doing something."

d-2. Didn't fit in with her aroused mood at all. Wanted to upset something.—Both unpleasant. (Gardens) the worse."

Subject "K"

Mar 19, 1913.

a-1. "Both were pleasant of course, but the palace made him feel big. In the other he was just one of the crowd. In the palace he was intimate with the people of the place. Attitudes alternated."

a-2. "Wasn't that difference. "Palace" got more commonplace. B. P. L. recognized. Other the approach to a very magnificent house. He was a spectator admiring, 'inquisitive,' more interest in it. Aesthetically admired the pillars in B. P. L. more. Association hurt B. P. L. He thinks of it as just an ordinary building."

b-1. "This time interest was more for the large building in the background. Other too isolated and simple a place.

"The big building seemed far away. A good many rooms; worth seeing.

"Still admired the pillars and the magnificence of the square, but it was too simple.

"No interest in soldiers."

b-2. "More curiosity now for the house. Pleasant. Other not so much as before; too isolated. Might have been a jail. House in the open, considered the surroundings."

c-1. "Liked the picture with the soldiers much better than the other; more life in it. Other got monotonous.

"Soldier picture better than before."

c-2. "No difference from b-2. Liked the approach to the house better."

d-1. Soldiers seem more pleasant than before. Enjoyed the march of the soldiers . . . and the music; and wanted to be in the big building.

"Other more monotonous, commonplace."

d-2. "This time thought of the house as the approach to the court-yard. (I told him to pay attention to the transition). Not so pleasant as the picture on the street (soldiers).

Transition not difficult in either case. Contrast helps his feelings."

Subject "I"

April 5, 1913.

a-1. "Feeling-tone . . . as long as he remained passive, the two reinforced each other steadily. When he tried to grasp details of the street scene it was rather painful, detracted from the feeling-tone. When he just took it easy and let them come both were very pleasant, and steadily reinforced each other. Feeling for the two much the same. Same bodily processes. And the different aspects of the soldier picture—the feeling for the glamour of it persisted during exposure of other. Reverse not true. (Speed difficult.)"

a-2. "The familiar one is more pleasant. Speed too great for the new one. Picture itself pleasant, but its disappearance so soon very harrowing. Felt eager to get more details. Over-effort to accommodate the eyes; haste, a sort of diffusion of energy generally. Tension in the back of neck, etc. An effort to prolong the image seems to proceed from inside the head. Strange tension.

"Relaxation was added to the enjoyment of the other picture. Yet there was a desire to get back to the other and solve it."

b-1. "A tendency to concentrate attention on soldiers. Other almost passed out of sight in several cases. Very marked increase in the feeling-tone for soldier picture. Could understand it much better. Doesn't have to begin again each time. Pleasant, feeling varied, mingled with curiosity."

b-2. "Much the same change in appreciation of (Gardens), but it didn't interfere with the appreciation of the palace (B. P. L.) Transition almost instantaneous and practically unnoticeable. Whole process of apprehension and enjoyment practically the same in the two. House part of (Gardens); became quite familiar."

c-1. "Associations begin to come in. He "recognizes" the pictures. Could go from one picture to the other easily this time. Palais Royal and Pont-Alexandre, facing Louvre. More interested in architecture than in the soldiers."

c-2. "Nothing to be added to b-2. Vines noticed this time. Feeling identical throughout."

Series V dealt with the relations of humor and aesthetic and religious sentiment. In trials-1, Katarina Kyrka in Stockholm was used with a humorous picture of two dogs and a bottle

of champagne. In trials-2, the church is replaced by another dog picture, two pups tumbling out of the basket of a balloon as it strikes earth. In trials-3, Stephans-kapellet is used with the other church. The speeds were (a) 36; (b) 24; and with one subject, (c) 12. The results were very much the same for all subjects. Those of "F" will be taken as an illustration. Each trial lasts 30 seconds.

Subject "F"

Mar. 21, 1913.

a-1. "Couldn't get much out of it. One humorous, other beautiful. So disparate that they did not seem to influence. Lines of "school building" pleasing; dogs humorous. Pleasant all through. A slight break at transition. Didn't belong together at all."

a-2. (Was laughing to himself all the time.)

"Reinforced each other. Not in the same place. Dogs falling out of the basket are enjoying it, but he couldn't make out the basket, who was pulling the strings. Whole thing frolicsome. Transition much less marked; hardly noticed."

a-3. ("Oh, that's fine"; spoken at beginning.)

"That's beautiful. Big brick church magnificent. Not just sure what the other is, school, court-house, or house. Supported each other, just as the two dog pictures did. Grandeur of architecture, especially in church; lines of other not so clear because of the trees, etc.

"Transition very slight."

b-1. "More incongruous. Transition at first startling. Couldn't take the dogs as humorous as before. Beauty of building didn't strike him as it did before. Dog situation is rather trifling. Dog not as funny as he wants to be."

b-2. (Laughing again.) "They are funny; you can't help reacting that way. Discovers now that there was a good deal of tension in b-1. Relieved now. Both pictures funny."

b-3. About the same as before. Of course some of the newness is gone, but the same relationship. They mutually support each other.

"Immensity of space prominent; all out-doors. He notices difference in his breathing.

("Dogs rather cooped up—in a yard, or something of the sort.")

In Series VI, I selected two winter scenes and two summer, and used first one of each, then the two winter scenes and the two summer scenes. This was repeated at speeds 36, 29, and 24. I wished to study the interference of the complex attitudes towards the two kinds of scenery. With all the subjects except "I", there was an interference,—'discord,' 'loss of bearings,' 'a slight conflict,' 'vehement,' 'senseless,' 'hard to go from one to the other,' etc.

I believe the above will be a sufficient indication of the methods and results in this section. The important points seem to be these: The frequent apperceptive synthesis depends upon the objective similarity of the pictures, and is of only minor importance for us here. The tendency to increase 'by contrast' comes when the general field of appeal is the same. With complex presentations there is a marked tendency to selection or assimilation, working towards identity or direct opposition. Mixed or parallel feelings seem to occur when the two separate attitudes differ slightly in meaning or field of appeal. They may be either of the same, or of opposite, value. They occur (with the materials used) only with certain subjects, and seem to depend upon the scope of attention, though only roughly so. They occur only when the feelings are well-marked. The parallelism is often one-sided, so to speak. A strong feeling may persist without inhibiting the weak feeling, while the latter is, as a rule, broken. The most frequent results are contrast or inhibition.

The effects of the different speeds need no discussion at this point. They come out more clearly in the use of the method of continuous variation. Beginning with Series VII the work of this section was mostly at high speed, beginning with 72 and working downwards. As still higher speeds were used in the later sections, there is no harm in omitting the remainder of the present one.

We now come to the experiments with variation of speed within the single trial. The apparatus was rather crude, so that the results are valuable chiefly in a qualitative way, though they give some indication of the possibilities of quantitative work.[19]

[19] The disk was revolved, during this season, by means of a direct-current motor, controlled by a rheostat.

After a few preliminary trials with speed constant, the work falls into the following divisions: *b 1,* trials starting at about 25 pairs of exposures per minute and gradually increasing to about 50. In this section no special directions were given as to the attitude to be assumed towards the experience. The task was the same as in A. 4, with the greater emphasis upon the tracing of the course of the feelings; *b 2,* consists of trials in which the subjects were asked either to try to get the feelings or to be passive; *b. 3,* the concluding section, consists of two series of trials with distraction, in the form of mental arithmetic. These trials were expected to throw some light on that part of our hypothesis (conclusion of A. 3) which refers to the scope of attention. In the last two sections, high speeds were used.

The materials were those of the first season. All the subjects except "K" were new, and I wished to extend the results with the same pictures.

Selections from the results of b.1 and b.2, and the two series of b.3 will now be given.

b. 1. Method as stated above, trials lasting about 45 seconds.

Subject "A"

Oct. 8, 1913.

Trial 1. Riksdagshuset & Courtyard (B. P. L.)

"Picture with columns very pleasant. Other about indifferent. Suggestion of militarism once or twice, somewhat disagreeable, but pleasure did not disappear even then. Was occupied almost altogether with the column one.

"A constant background of pleasure, at times tinged with unpleasantness."

Trial 2. N. E. Gardens (portico) & B. P. L.

"My! That's great. Both quite pleasant. The new one is the better of the two. As the speed increased, tended to dwell on the new one, even when the other came, and the other became less pleasant than before.

"The feelings differed, but both pleasant. Cannot describe the difference.

"At first, the two feelings alternated, distinct. Then the feeling for the new one became a constant background."

Trial 3. Rear View Paul Revere House, & Arbor (N. E. Gardens.)

"Arbor—happy, quiet.

"House—poverty,—squalid.

"As trial went on, attention was monopolized by the arbor. At first feelings alternated, then the happiness became constant, and was momentarily tinged with sadness,—a sort of sad happiness. The happiness during exposure of arbor was unalloyed."

Trial 4. Road to Sleepy Hollow & Arbor.

"There is a difference in the feelings; the old one secluded; nice place to walk with a girl; other open. Marked change in the attitudes at transition; alternated distinct until very last, when tended to dwell a little on the old one, but there was no holding over of one feeling into other this time. + all the time, in varying degrees, i.e. the things themselves.

"A little unpleasantness came in at transition, due to the change. Wanted to dwell on the arbor."

Oct. 22, 1913.

Trial 1. Kitten on pedestal & I am for Prohibition.

"The wet cat seemed funny. This feeling waned.

"Other pleasant, too, but different. Wanted to pat it.

"The feelings alternated. Then humor waned, and the other feeling tended to hold over. The feelings overlapped."

Trial 4. Elsie Ferguson & Ancient.

"One attractive; other horrid, ugly, didn't want to see it at all, but couldn't shut it out.

"Feelings alternated at first, then towards end the pleasure seemed to be combined with the repulsion.

"There was some notion of assimilating the two in perception, which made the feeling all the more horrible.

"He has no doubt whatever about the reality of this "awful loveliness."

Trial 5. Elsie Ferguson & Audrey Burton.

"Both pleasant; at first not much different, but later whenever the girl with the hat came, he felt like saying, Oh you! This feeling more sexual, other dignified. These feelings alternated all through. No blendings.

"No tendency to assimilate the two."

Subject "B"

Oct. 7, 1913.

Trial 1. Paul Revere House & Road to Sleepy Hollow.

"At first old house was unpleasant, but got adapted to it.

Then when the speed increased, the effort at adaptation was unpleasant, chiefly due to eye sensations. No longer any time to enjoy trees. The feeling for the pictures themselves disappeared."

Trial 2. N. E. Gardens (Arbor) & Road to Sleepy Hollow.

"Noticed a tendency to breathe in rhythm with the two. Didn't like the high speed. Couldn't enjoy either or get olfactory imagery.

"2 much the more pleasant trial.

"In 1 pleasure added to trees, due to contrast. In 2 trees not so distinctly pleasant as before, because the apple blossoms were better."

Oct. 14, 1913.

Trial 1. Luise von Preussen & Leksand.

"Very pleasant until about halfway through; then (as speed increased) the pleasure diminished. Liked the girl a little better."

Trial 2. Leksand & Old woman of Gloucester.

"This time liked the high speed better, except the very highest.

"The old lady (caricature) was very disagreeable. Good one a decided relief.

"High speed cut out unpleasant details.

"Feelings entirely distinct; simple alternation.

"Leksand better in second trial than in first."

Oct. 28, 1913.

Trial 2. Madame Recamier & Dude with Bundles.

"At first increase of speed increasingly pleasant, then faded again.

"Female fairly pleasant, but her dress was unsuitable. A little revulsion; this held over sometimes and was then with the humor. No holding over the other way."

Trial 3. Madame Recamier & La Cruche Cassée.

"At first pleasant, but as soon as he noticed details of dress, whole thing was unpleasant.

"The former one not as bad as the new. The old was a little good by contrast. The worse feeling held over into the exposure a little."

Trial 4. Two old Salts & La Cruche Cassée.

"The pleasant feeling held over all the time. Occasionally

there was a slight ill-defined unpleasantness *along with the pleasure,* during exposure of girl. Once there was a break in the pleasure."

Trial 5. My Chauffeur & Remembered by St. Valentine.

"Whole experience pleasant; less so towards the end. Old lady more pleasant, humorous. The humor was held over a good deal, sometimes through entire exposure of girl; at others crowded out by a quieter feeling.

"Sometimes the girl seemed to be smiling, but he doesn't think she really was. Seemed to be a carrying over of his own Einfühlung."

Nov. 4, 1913.

Trial 1. Mona Lisa & Old woman of Gloucester.

"The rate seemed to be pretty much indifferent; a little too fast, but increase didn't seem to make any difference. Mona Lisa slightly pleasant; other only slightly unpleasant.

"The pleasantness of Mona Lisa held over an instant, appearing localized near the centre of the field; the unpleasantness from the wench seemed to 'wiggle' in from the lower left corner, and when partly in, the pleasantness from the other 'exploded' and the unpleasantness spread over the whole picture."

Trial 2. Österäker & La Vergine Afflita.

"The higher speed was slightly unpleasant.

"The nun slightly sad and very slightly unpleasant; feeling of depression; the Dutch girl rather pleasant. In passing from the girl to the nun there was abrupt change of feeling. The pleasant coy feeling became suddenly sad, distinct empathy. The slightly unpleasant feeling of the nun held over nearly every time (during slower rate) into the other picture, and the pleasantness of the Dutch girl seemed to come from underneath and push up through, and shove the sad feeling aside."

"Trial 3. Hallowe'en Greeting & El Divino Pastor.

"Faster rate got unpleasant, as before. Not time enough to see them.

"Jack o' Lantern pleasant, quite pleasant. Other less pleasant; looked sad.

"Alternated distinctly; two degrees of pleasantness.

"Suggestion of the lesser degree of pleasantness of the shepherd holding into the higher degree of the jack o' lantern, which immediately crowded it out. No tendency in the opposite direction, I'm sure."

Subject "N"

Oct. 31, 1913.

Trial 1. Mona Lisa & Old woman of Gloucester.

"Slight unpleasantness in both.

"Doesn't like the smirk in Mona Lisa. The other counteracted that and had a slight pleasantness on that account. On the other hand, the coloring in Mona Lisa is pleasant, and the other bad by contrast. Mona Lisa was always the main thing, and the other a foil for it, either good or bad. Could not say just how the feelings behaved."

Trial 2. Repetition.

"Once with Mona Lisa there was a mixed feeling, unpleasantness dominant, but with a slight pleasantness due to the colors. Mona Lisa became on the whole more unpleasant and the other more pleasant. Feelings more definite this time.

"Complete alternation. As speed increased, the feelings now and then sank to indifference."

Trial 3. Duchess of Devonshire & A servant girl down in North Bingham.

"At beginning, there was mixed feeling in each. Each was partly pleasant and partly unpleasant. Then for a while the painting was pleasant and the other unpleasant. Then as speed increased there was a transition period after which the feeling was reversed, painting unpleasant and other pleasant. In transition period whole experience was unpleasant. As speed increased, painting got simperish and sickish; other a solid, workaday thing then. At very end, everything became indifferent. Complete alternation."

Trial 4. No. 7 & What are you Laughing At.

"At first it was awful. Man sitting on bench first. Mixed pleasantness and unpleasantness. When the other came it was a great shock; result a muddled state of pleasantness and unpleasantness. The whole soon became indifferent."

Trial 5. Elsie Ferguson & Ancient.

"Pretty girl first. Change to other an awful shock.

"Each had its own feeling tone; each tended to hold over a little while the other was developing; so at transition there was a slight mixture. Towards the end the rapid change seemed to color the whole experience with unpleasant, yet at the same time the girl was pleasant and the other unpleasant. The spots of pleasantness were shorter than those of unpleasantness."

Trial 6. Elsie Ferguson & Mrs. Aaron Ward Roses.

"The first change from girl to roses was luscious, but later the same unpleasantness at transition came in, i.e. the same sort of thing, but not so strong. Both were pleasant. The unpleasantness partly overlaps the other feelings,—not continuous as before."

Subject "K"

Oct. 16, 1913.

Trial 1. Vigée Lebrun & Daughter, & Snakes.

"Snakes first; no feeling at first, just studied it.

"Then a great gush of pleasantness, when the woman and girl appeared; seemed nearer, more alive.

"A tendency to ignore the unpleasant one. This tendency increased with the increase of speed. Unpleasantness was diminished, did not last as long as pleasure. The two feelings seemed separate in their actuality, but there was a continuous residue of knowledge that the pleasant one existed."

Oct. 23, 1913.

Trial 1. Winter sports, and dark interval.

"Very pleasant."

Trial 2. Winter Sports & God Help the Poor Sailors.

"Very good contrast, both slipping, etc. Girls pleasant, and man pitiful. Tried to ignore him.

"Winter sports a little more pleasant the first time than this.

"Not a direct contrast, but one between sympathy and aesthetic enjoyment.

"Pure alternation *throughout.*"

Oct. 30, 1913.

Trial 1. Courtyard, B. P. L. & Oh Gee!

Not very much feeling.

"(B. P. L.) pleasant, other somewhat unpleasant, but there wasn't very much about either."

Trial 2. Luise von Preussen & Oh Gee!

"A good deal of feeling. The new one seemed to be nearer, more alive; pleasant. Man slightly unpleasant, about the same as before. The whole mood seemed to be pleasant. He was more charitable towards man. The man seemed less significant. The unpleasant feeling seemed merely to push the pleasure a

little aside, so to speak. The pleasure was continuous, as a background. The displeasure was only superficial."

Trial 3. Mona Lisa & Old woman of Gloucester.

"Pretty great contrast; a tendency to bring the pleasant one closer.

"Complete alternation throughout. + feeling far stronger.

"They seemed to be in two different worlds. The contrast was so sharp that they could hardly be compared.

"Seemed to him that Mona could not know of the existence of the old hag.

"The two seemed opposite in every way; one attractive, other repulsive; one seemed close, other distant.

"Feelings weakened as speed increased."

Subject "D"

Oct. 27, 1913.

Trial 1. Girl learning cello & 38.

With girl, he wanted to draw the bow across (Einfühlung).

"Other gave him the feeling of toothache; rather unpleasant. The unpleasant feeling seemed to last longer, to be carried over into exposure of other picture.

"No mixed feeling.

"When the speed increased, there was no feeling whatever."

Trial 2. My Chauffeur & Remembered by St. Valentine.

"The young dame was very pleasant. Other at first mildly entertaining, later on got monotonous; then conflicted with the other. The thought came that ever the 'belle dame' might become the other one. That was unpleasant. The feelings were quite distinct.

"The shifting of the light is unpleasant. This persists even during exposure of pleasant card. The displeasure of anticipation of removal is present simultaneously with pleasure in the picture."

Trial 3. N (young woman in evening dress sitting on the back of a chair, & Ks (children playing).

"A great deal of curiosity to find out what the girl was doing. She became very unpleasant. The other mildly pleasant at first, became more pleasant as other grew unpleasant. The unpleasantness seemed to be stronger, seemed to survive even when the other card came."

Trial 4. M (young lady) and Ks.

"Children still pleasant, but not so much so as before.

"Didn't like girl. The feeling held over into exposure of children.

"Once there was a trace of parallelism."

Subject "E"

Oct. 15, 1913.

Trial 6. Hazel Troutman & Ancient.

"Contrast greater as speed increased, but not very much so. Actual reaction to unpleasant picture fades out into difficulty of seeing it.

"The feelings delay each other. Can feel one crowding out the other. They do not seem to actually overlap. Hard to describe."

Oct. 22, 1913.

Trial 1. Kitten & I am for Prohibition.

"The little one was agreeable; other unpleasant.

"Contrast in both sympathy and touch imagery.

"Simple alternation throughout."

Trial 2. We Used to be Pals, & I am for Prohibition.

"Dog comic. Feeling was carried over a bit. Interpretation of cat was altered. A little more inclined to smile at cat."

Trial 4. The Garden Wall & Among the Poppies.

"The one on the wall was more pleasant, easier to see, but both pleasant,—and a little discomfort at the difficulty was carried over into the exposure of the better one, but not referred to it. Seemed to interfere with the perception of the better one.

"Pictures similar in feeling, but a slight break between."

Trial 5. The Garden Wall & Oh Gee! The World belongs to me.

"Interesting. The prominence of the man's feet called her attention to the undue prominence of the child's legs and feet.

"The pleasure in the subject (children) as great as before, but alternated with displeasure at the poor drawing.

"Picture of children was refreshing by contrast with the other. The other suggested the cynical attitude. No redeeming features about it.

"The feelings alternated throughout, with the exception of the influence on interpretation spoken of above."

Nov. 5, 1913.

Trial 1. Österäker & La Vergine Afflita.

"Interesting; posed so much alike that it was very easy. Both

pleasing. Peasant girl more natural; other—massing of color was good.

"At low speed peasant girl more pleasant; at high speed, other.

"The two seemed to help each other. The Madonna seemed lacking in expression, owing to contrast with other."

Trial 2. 98 & La Vergine Afflita.

"Madonna looked quite natural; other amusing at first, but before he disappeared he was quite painful. Madonna still aesthetically better, too.

"Distorted figure produces a sort of tension, empathy. Could feel her own face smoothing out when she looked at the Madonna. Even the pose of the hands seemed natural this time. Seems as if it were a better copy."

Nov. 5, 1913.

Trial 3. Österäker & Lily Pool.

"Girl looked rather artificial in comparison with children. At high speed the girl was more pleasant, however.

"Effort to see details in picture of children a little unpleasant. In seeing this picture the unpleasantness is there with the pleasure.

"No blending of the feelings for the separate pictures."

Trial 4. Mona Lisa & Old woman of Gloucester.

"Old hag very unpleasant. Mona Lisa pleasant by contrast. The first time she ever saw her to like her.

"As trial went on, details came out.

"There was a marked contrast between the repose and the distortion. Both vague empathy.

"+increased.

"—diminished; became more an intellectual distaste.

"The repose became the dominant.

"The pleasure crowded out the displeasure. No blending."

Subject "G"

Oct. 14, 1913.

Trial 1. Luise von Preussen & Leksand.

"Chief thing was annoyance at the flicker.

"Old lady was rather amusing. Girl indifferent."

Trial 2. Leksand & Old woman of Gloucester.

"Both unpleasant; increasingly so.

" . . . Leksand seemed different this time. Instead of amusing, her expression was unpleasant. Bad features were brought out by similarity with other."

Trial 3. God Help the Poor Sailors, & Dude with Bundles.
"More or less amusing. Increase of speed seemed to make no difference."

Trial 4. In the Garden & Among the Poppies.
"At first almost indifferent, peaceful. As speed increased, a little unpleasant.

Trial 5. God Help the Poor Sailors, & Among the Poppies.
"One amusing, the other pleasant, increased as speed increased, even to the highest speed.
"Contrast made the children seem sort of cute."

The individual difference in the tendency to parallel feelings should be noted for comparison with the later results. The tendency is quite strong with "A" and "B," somewhat less so with "N," still less with "K" and "D," and absent with "E" and "G."

b.2. In this section the method of taking the introspection was somewhat altered. The subjects were asked to note the points at which changes in the nature of the experience occurred. As a general rule, this was done simply by the word *now,* spoken at the time of the change, when the speed was recorded by the experimenter. Occasionally a very brief statement was made. Immediately after the exposure, the introspection corresponding to the previous signals was taken down.[20]

At first each trial started with the lowest speed, increased to the highest, and then decreased again. The section began with a few experiments in which the task was the following:— (a) to note the best rate; (b) to find the point where the feelings are gone; (c) to find the point where the feelings begin to go, and describe the effect.

A trial with Subject "D" will serve to illustrate the method.

Nov. 10, 1913.
Trial 1. Good Bye, & God Help the Poor Sailors.
(a) "Strongest at lowest speed". (43)
(b) "All gone at 57."

[20] The points of the rheostat were numbered, and these numbers were recorded at the signal word. At the close of the hour, the number of exposures per minute for each point recorded was taken. As the apparatus was generally pretty constant during any single hour, this method was fairly satisfactory for such a preliminary study of the method.

(c) "At 54 on way up, 53 on way back. Feeling at this point compared to other was like pointing a cap pistol at a man compared with a revolver; reality gone. Dog picture sad, other ludicrous, but not enough to make him laugh."

It became evident that the results were much influenced by the attitude taken, passive or active. A few trials were made to compare the results in the two cases. In general the active attitude, the attempt to get the feelings, was successful. The feelings came at much higher speeds than when no effort was made. With "E" the reverse is true; e.g. on December 3d, in trial 2, passive, the feeling disappeared at 93; in trial 3, active, same materials, it disappeared at 74. In another pair of trials, with new materials, similarly, in trial 3, active, the feeling 'became rather intellectual, picture recognized as the sort of thing that gives pleasure', at 70; in trial 4, passive, same materials, this effect did not appear until 83. With "A", there is little if any difference in the two cases.

The greater part of the work was done wtih the passive attitude. The results bring out very clearly the influence of the change of speed upon the feelings,—the gradual sifting out of portions of a complex reaction and the variations in dominance of one feeling or the other. The individual differences in the time required for development of feeling are very marked.

The following will serve as illustrations:

Subject "B" (eyes tired)

Nov. 18, 1913.

The first two trials run from speed 25 to 45 and return, the next two from 42 to 87 and return. (Method, passive).

Trial 1. Rear View, Paul Revere House & New England Gardens, Arbor.

"At first and last apple blossoms quite pleasant, house slightly unpleasant. At 41 on way up house getting more unpleasant, apple blossoms less pleasant. At 41 on way down two about equal and opposite. At 28, apple blossoms getting pleasant again, at 26, house unpleasant again."

Trial 2. Georgetown Road & N. E. Gardens.

"Best at lowest speed. At 29 on way up woods the more pleasant. At 35, two equal. At 38 on way down, both had

weakened a little. At 34, both got stronger. At 29, woods again the more pleasant.

"A little more empathy in the woods. Noticed that sometimes he inhaled when he looked at woods, just as when looking at flowers."

Trial 3 (pictures of trial 1).

"At first unpleasant stronger than pleasant. This increased at 49. At 56, about equal. At 74, unpleasant disappeared; at 87, pleasant. On way down, pleasant came in again at 70; unpleasant at 56. At 48, unpleasant stronger than pleasant. At end tending towards equality."

Trial 4 (pictures of trial 2).

"At 44, road more pleasant. At 49, two equal. At 74, flowers gone. At 87, all gone. On way down, at 70, road slightly pleasant; at 57, blossoms slightly pleasant. At 49, two equal. At 45, road more pleasant.

"Different kinds of pleasantness, Road, a sort of outgoing feeling, open, etc. Tendency to extend himself. Other, olfactory imagery pleasant. The road attitude held over a little into other as rate became slower again."

Comparison of the results of the increasing part of the trial with the decreasing serves as a check upon the effect of familiarity, fatigue, etc. When the results are fairly symmetrical, they may be taken as indicating the effect of the rate. When this is not the case, the results are of doubtful value. The constant method, especially as in a.1, could also be used as a check.

Concerning the effect of high speed, "N" says (Dec. 5, Trial 2) alternation 'so fast that the complete feelings do not come, so conflict is gone, and the experience is pleasant.' He does not 'sink himself into the two alternately as before.' "G" (Dec. 2) speaks repeatedly of a 'ghost-like effect', 'unreal', 'not time for the meaning to develop, no context.'

Other similar phrases may be found scattered all through the work of this year, and in A.4. Unreality seems to result from (a) lack of motor response, Einfühlung; (b) lack of associations. I believe that such results with normal persons may throw some light on the problem of the abnormal experience of unreality, as discussed by Packard.[21]

[21] The Feeling of Unreality, *Journal of Abnormal Psychology*, V. 1, pp. 69-82.

The latter part of the work of this section began at the highest speed and went to the lowest. It was intended to bring out the individual differences in quickness of response. It will not be necessary to quote any of the introspection. Suffice it to say that there is very great variation, some getting feeling quite often above 100 (single exposures less than 3/10 second) while others required much longer exposures. More adequate apparatus must be devised before accurate results can be obtained. The subjects, arranged in the order of quickness of response, from the slowest up, are as follows:—"D," "E," "K," "N" and "G," "A" and "B."

These results, so far as they go, indicate a positive correlation between quickness of response and the tendency to parallel or mixed feelings.

b.3. This final section, as mentioned before, consisted of two series of trials with distraction. This took the form of mental arithmetic. The results throw some light on the relation of the tendency to mixed feelings and the scope of attention. They are not very satisfactory, however, owing to the fact that the adding soon gets mechanized, and also that some of the subjects add visually, so that interference of an unwelcome sort came in. Still, though two series are hardly a sufficient basis for generalization, the results seem to indicate that distraction has less inhibitory effect with those subjects who have the stronger tendency to mixed feelings.

The method was as follows:—There were four trials in each series. In series 1, the pictures were No. 38 ("comic") and Bridge in Franklin Park. The trials began at medium speed, and the speed was increased to the highest. In trial 1, the subjects were directed to be passive, to make no effort to get the feelings. They were asked to begin with 13, and add 17 repeatedly as long as there was any feeling, or in case there was no feeling at the start, to continue adding until the light was turned off. In trial 2, the method was passive, without distraction. Trial 3 was active, with distraction, to begin with 9, and add 17 repeatedly, and try to get the feelings. Trial

4 was active, without distraction. The point at which the adding was stopped indicating complete inhibition of the feelings, was recorded. In the trials without distraction, the introspection was taken as in the previous section.

"D" and "E" had no feeling in either trial 1 or trial 3. "G", in trial 3, 'succeeded in getting a feeling of pleasantness from bridge once about halfway up'. Apperception also is inhibited; there is only 'a sort of recognition of the presence of certain colors,' etc. "K" 's and "N" 's results are quite similar. In trial 1, they both tended to attend either to the adding or to the pictures, and got feelings when they attended to the pictures. In trial 3, both had considerable feeling, though less than in trials 2 and 4. "K" had parallel feelings at high speed in trial 2. "A" and "B" had feelings in all four trials, less in the trials with distraction. In trial 1, "A" had feeling only for the dog, 'a mixed feeling, humorous, but not very aesthetic.' "B" found 38 indifferent, the landscape pleasant. In trial 3, both "A" and "B" had feeling for both pictures, in complete alternation. "A" had mixed feeling in trials 2 and 4; in 2, humor and pleasure; in 4, pleasure and displeasure.

In series 2, the pictures were the Arbor (N. E. Gardens) and Paul Revere House. The method of the trials was in reverse order; 1, active; 2, active with distraction, begin with 19 and add 13 repeatedly; 3, passive; 4, passive with distraction, begin with 7 and add 13 repeatedly.

The subjects fall into the following order, when arranged according to the intensity of feeling in the distraction trials:— "D," "E," "G," "K," "A," "N," "B".

The results of these two series point towards a positive correlation of scope of attention with the tendency to mixed feelings, when compared with the results of b 1. Combining the results of the two series, the subjects rank as follows:—"D," "E," "G," "K," "N," "A," "B."

The ranks in b.2 were: "D," "E," "K," "N" and "G." "A" and "B."

In B. 1 they were "E" and "G," "D," "K," "A," and "B."

The results are not sufficient to warrant any distinction between those paired in the ranking.

Using Spearman's "Foot-rule," R is as follows:

(1) Tendency to parallel or mixed feelings and quickness in response,—.562. . . .

(2) Tendency to parallel or mixed feelings and scope of attention,—.687. . . .

(3) Quickness in response and scope of attention (possibly scope of response would be better)—.75.

$$\text{P. E.}_R = \frac{0.43}{\sqrt{7}} = .161\ldots$$

Converting R-values into r-values (using Table 6 in Whipple's Manual, rev. ed. Vol. I), we get the following:

1) .77 . . .	P. E.$_r$ $=0.6745\frac{1-r^2}{\sqrt{7}}$	$=.101$
2) .88		.056
3) .93		.033

Our hypothesis, stated in A.3, seems to have been confirmed so far, and is therefore worth further testing.

It remains now to sum up our results and consider their bearing on the theory of feeling.

SUMMARY AND CONCLUSIONS

The 'law of algebraic summation' of feelings is quite inadequate to account for the results obtained in the present investigation. Simple algebraic summation is only occasional. Displeasure may inhibit displeasure, rather than add to it. (*Cf.*, *e.g.*, the last of the results quoted in A.2.) The resultant feeling depends very closely upon the relations of the whole apperceptive attitudes towards the two separate stimuli, and this, moreover, in a manner that suggests a much closer relation of feeling and intellectual processes than has usually been taught. 'Feeling' and 'meaning' often seem well-nigh identical.

The most important of the results may be summarized as follows: When the two feeling-tendencies are of like intensity, if the total reactions, the apperceptive attitudes, are widely dissimilar, the result is inhibition, whether the feeling-tendencies are of the same or of unlike sign. Inhibition diminishes wtih increasing similarity, until, with some subjects, there is a tendency to parallelism, and, rarely, fusion. The latter seems to occur usually along with an apperceptive synthesis of the stimuli, and to depend largely upon the objective similarity of the drawings, etc. When the fields of appeal become nearly identical, the feelings either become one, or 'increase by contrast,' in alternation, according as they are of like or opposite value. Parallelism does not occur with feelings of unlike sign when the general attitudes are the same. When the feelings are of unequal intensity, inhibition continues farther up the scale of similarity. In some cases a strong feeling persists without inhibiting a weak feeling, during the exposure of the stimulus which gives rise to the latter. The weak feeling is, as a rule, broken off with the appearance of the other stimulus.

Inhibition becomes more marked the more rapid the alternation of the stimuli, the whole experience becoming 'unreal', 'cold', 'purely intellectual.' The point at which this occurs varies greatly from subject to subject.

Transition, in cases of inhibition, is marked by a kinaesthetic readjustment, usually unpleasant, described by such phrases as 'loss of bearings,' 'a slight conflict,' 'hard to go from one to the other,' etc. This unpleasantness often overlaps the feeling due to the separate stimuli.

The individual differences are of great importance, the occurence of parallel or mixed feelings having been shown to be correlated with (1) readiness of response—the occurrence of feeling even with rapid alternation—and (2) with scope of response—the occurrence of feeling from the stimuli offered, despite the distraction of a task in mental arithmetic. The indices of correlation are:—(1) .77, P.E. .101; (2) .88, P.E. .056.

Cases have occurred in which feelings were reported increased by attention to them, in the intervals between exposures of the stimuli, as well as cases in which feelings were inhibited by attention to them. *Cf.* the introspections marked N.B. in A.2.

Experiments on excitement and calm, humor and solemnity, etc., gave results closely similar to those with pleasure and displeasure. Parallelism is a little more frequent with these other feelings.

We may now discuss briefly the value of these results. Titchener's criteria for affection as an independent element seem to have failed. Qualitative antagonism is generally found, but mixed feelings do occur, under certain conditions, which seem to have been hit upon in our work. Besides, inhibition occurs with excitement and calm, etc., as well as with pleasure and displeasure. It seems on the whole quite likely that the special pair of feelings known as 'affection' should be taken along with other attitudes, viewed as responses of the organism, and studied, like the others, with due regard to individual differences. It may quite well be that in this case, as in that of the thought processes, what is simple for one observer may be complex for another, while introspection may interfere with, or intensify, the process. We have found such differences in the present investigation. Titchener's discussion in Feeling and Attention, Lecture IV, from page 155 on, should be read with this possi-

bility of different types of organization in mind. I do not intend to attempt any defense of the tridimensional theory, but will only mention the fact that Titchener fails to take account of Alechsieff's critical discussions.

I have but little to add to Titchener's summary of the previous experimental work.[22] I should, however, insist that the negative results of Orth and Alechsieff are hardly conclusive. Consider:—In section VIII, 4, of his article, Alechsieff gives two sample introspections in which the feelings alternated, and says, "Aus diesen und 27 ähnlichen Versuchen kamen wir zu dem Schlusse, dass Lust und Unlust nicht gleichzeitig in unserem Bewusstsein existieren können, sie können nicht nebeneinander, sondern immer nur nacheinander von uns erlebt werden" (p. 262). In our work, there were several hundred trials which gave this same result, but there were also a large number in which mixed feeling was reported. A perusal of the two introspections given by Alechsieff will show that not only the feelings, but the awareness of the two stimuli, alternated, and it should be borne in mind that Alechsieff was purposely working with weak stimuli, '(um) jeden Übergang der Gefühle in Affekte (zu) vermeiden.' (page 169). As our results show mixed feelings only in certain of those trials in which the awareness of the two stimuli was also simultaneous, Alechsieff's results only go to confirm our own.

I suggest for consideration the following interpretation of our results:—

Biologically viewed, the fundamental features of life consist of certain periodic functions,[23] hunger, breathing, circulation, sex, hibernation, sleep, etc. As psychologists, we do not need to beg the question as to whether 'spontaneity' is a resultant of these functions or whether the latter form the primary conditions under which a certain psychical factor—(Royce's restlessness)—must work. In either case, behavior does develop, and sensori-motor coördinations are formed. The most important of these latter are the favoring and avoiding reactions,

[22] "Feeling and Attention," pp. 46-55.

[23] *Cf.* Münsterberg, "Psychology and Social Sanity", Chapter 1.

which in the course of development become very intricate and complex. The conscious correlate of the manifestation of these coördinations or attitudes is feeling.

The above view harmonizes completely with the customary evolutionary theories concerning feeling, but seems less mysterious. It also serves as a good basis to account for the behavior of the feelings.

Any presentation will have a certain field of appeal, *i.e.* the organism, with its periodic functions and acquired tendencies in a definite state of readiness, will take a certain attitude, a motor readjustment. Attitudes may conflict and result in complete or partial inhibition. If they are wholly unrelated, inhibition is the usual result. If the attitudes are similar and in the same direction, summation, or at least increase, is the result.[24] If they are similar and in opposite directions, the result is commonly a sort of pendulum effect, ('increase by contrast'), unless the two are very different in intensity. When the fields of appeal differ somewhat, the differing features sometimes disappear, ('assimilation'), sometimes survive. In the latter case the result is 'parallelism' or 'mixed feeling'. 'Mixed feeling' usually goes with apperceptive synthesis. The two become parts of one situation.

'Two streams of feeling, emphasized in alternation', is now intelligible. The common part of the two responses is continuous and stays at the same level of intensity; the differing parts do not die out, but first one, then the other, is the stronger, as the stimuli alternate. When the two responses are in opposite directions, the common part alternates in direction. The differing parts are more often lost, but in a good many cases do persist. Such is the view which I favor at present.[25]

It must be admitted that our results throw the way open,

[24] For an interesting quantitative study of inhibition and summation *cf.* Keith's, "The Mutual Influence of Feelings." Harvard Psychological Studies, V. II, pp. 141-157.

[25] The following, from the conclusion of Geiger's Bemerkungen, may be of interest in this connection:—

"Es ergaben sich hieraus die folgenden Gefühlsverbindungen. Die Verbin-

to some extent, for such notions as 'zentrale Mitempfindungen', 'Gefühlsempfindungen, etc. The question as to the relation between feeling and emotions is all-imporant here. In view of the similarity of our results and those of Johnston, as well as on grounds of comprehensibility, I am inclined to accept Titchener's criticisms of such theories.

A genetic distinction may of course be drawn between feelings that owe their origin to the direct effect of the stimuli and those which develop indirectly, on the basis of some periodic function, e.g., the attitude towards pumpkin pie. It seems unlikely that any sharp line should be drawn between the feelings of one class and the other, so far as their own nature is concerned. With this I leave the general theory.

Careful study of the behavior of feelings may have not only theoretical interest, but practical value. Certain applications are apparent from the passages cited in the Introduction. 'Dramatic

dungsgefühle sind, als nur durch die systematische Uebersicht erfordert, eingeklammert.

I. Verbindungen von Affektgefühlen.
  A. Verbindungen gegensätzlicher Gefühle.
    1. Gefühlsverschmelzung (Mitleid).
    2. Mehrdeutige Gefühlsverflechtungen.
      a. Gefühlsverdrängung (unangenehme Speise bei Hunger)
      b. Mehrdeutige Gefühlsverwebung (Sehnsucht)
    3. Eindeutige Gefühlsverflechtungen.
      a. Eindeutige Gefühlsvereinheitlichung. (überwundene Anstrengung)
      b. Eindeutige Gefühlsverwebung (Entrüstung)
    4. Zwichenverbindung zwischen Gefühlsverbindung und Verbindungsgefühlen.
      a. Gefühlssubordination (Rache, Neid)
    (5. Verbindungsgefühl: Vertiefungsgefühl)
  B. Verbindungen verschiedenartiger Gefühle.
    1. Gefühlsverdichtung (Überraschung)
    2. " —durchdringung (Kraft)
    3. " —coordination (leuchtendes Rot)
    4. " —überhöhung (Schreck)
    5. " —verknüpfung (freudige Überraschung)

II. Verbindungen von logischen Gefühlen.
  A. Verbindungen gegensätzlicher Gefühle
    [1. Verschmelzungsgefühl (Möglichkeit)]
    2. Gefühlsentgegensetzung (Zweifel)
  B. Verbindungen verschiedenartiger Gefühle.
    1. Gefühlsnebeneinander (neue Möglichkeit)

III. Verbindungen logischer Gefühle mit Affektgefühlen.
    1. Affektiv-logische Gefühlsdurchdringung (Gewissheit)
    2. Logisch-affektives Gefühlsnebeneinander. (unangenehme Gewissheit)

hedging', 'mixture of tones', and 'character-contrast', as discussed by Moulton, correspond closely to the three types of results in our work. Sully's discussion of the play-mood and the limits of the decorous shows that it is well for the dramatist to understand the behavior of feelings. Other practical problems are not far to seek.[26] Is it not of value to know that a feeling cannot be inhibited by its direct opposite, provided the original stimulus continues, since the result will be a return with increased intensity,—('increase by contrast'), whereas a feeling can be completely inhibited by another which is sufficiently different? The order of situations in plays and stories, the arrangement of pictures in art galleries, the order of slides in illustrated lectures, even the grouping of advertisements, whether in periodicals or street cars, to be effective must follow the laws of feeling. There is, then, work worth while to be done. The present investigation lays no claim to anything more than an indication of certain possibilities for future work.

The first requirement is adequate apparatus. The tachistoscope devised by Dodge gives a mirror reversal of one of the pictures. This is often very disturbing. Some apparatus must be found which shall eliminate this difficulty, and also permit of continuous alternation either with constant or gradually varying rapidity, as is desired. I have been unable as yet to work out anything satisfactory. I believe, however, that the most effective method would be that of the stereopticon, if a control could be devised.

When we have a workable apparatus, the many part-problems can be taken up carefully and thoroughly, e.g. the study of the effect of various lengths of trial upon the behavior of the feelings, upon inhibition, assimilation, etc., the problem of voluntary control of the behavior of the feelings, not merely the active and passive methods as we tried them, but attempts at fusion, etc., as well; the effect of fatigue upon the feelings, especially upon the control of the feelings, etc., etc.

In the hope that the richness of the field has been indicated, I now close my discussion.

[26] *Cf.* Chapters I and VII of Münsterberg's "Psychology and Social Sanity."

ACKNOWLEDGMENTS

It is my pleasant duty to acknowledge my indebtedness to Professor Münsterberg, who suggested the problem and gave me much helpful advice; to Dr. H. S. Langfeld for further suggestions; to my subjects for their patience and care; and to Miss Olive French for invaluable assistance in revising my manuscript.

Cambridge, Mass., 18 April, 1914.

A STUDY IN ASSOCIATION REACTION AND REACTION TIME

WITH AN ATTEMPTED APPLICATION OF RESULTS IN DETERMINING THE PRESENCE OF GUILTY KNOWLEDGE

I. INTRODUCTION

The Problem Suggested

In the spring of 1909 the writer became interested in the possibility of making an application of the association reaction as a test for guilty knowledge of crime. With the purpose of satisfying myself that I was right in believing in the success of such an application, I undertook to test four subjects selected by another person. One of these subjects had been put through an act, the details of which I had myself arranged. The problem was to determine which one of the four subjects tested had gone through this experience. The test proved successful in that it gave data which made it possible to solve this problem. However, the results were not as convincing and reassuring as the optimistic writings of Münsterberg and others had led me to anticipate. For this reason another similar test was made, with utter failure as the result.

Even after this second test, my faith in the efficiency of the method was still firm, although I had begun to doubt the value of the criteria used to judge the results of the test. There were several facts that stood out rather prominently in these preliminary experiments part of which seemed to be out of harmony with the statements that had been made concerning the association reaction times. There were many instances in which there were as long, or even longer, reaction times among the non-guilty, as among the guilty subjects. There were also instances even among the guilty subjects in which the reaction times to the non-guilty words were as long as, or even longer than, the

reaction times to the guilty words. As no introspections were taken in these preliminary experiments we could not tell the cause of these lengthened reactions. Yet we could not help but wonder whether they were all due either to the direct inhibition by the subject of the first association that came to him, and the substitution of some other, or to the retarding effect of the arousal of an emotional complex, as both Jung and Münsterberg would lead us to believe.

It was also noticed that, in general, with nouns the reaction times seemed to be longer than with adjectives. This naturally raised the question of whether or not the verbal form of the stimulus had any effect upon the length of the reaction time. That there appeared to be more noun than any other form of response to adjective stimuli raised the connected question of whether this was purely accidental in the few cases we had before us, or whether the verbal form of the responses really does have some relation to the verbal form of the stimuli. Naturally from these two questions arose a third—does the verbal form of the reaction have any influence upon the length of the reaction time?

One of the guilty associations in the first preliminary test was stamp box. The words stamp and box were chosen as two of the test words and, accidentally, were placed in the test list in such an order that the one followed the other. In most of the cases the second word of this pair brought as a reaction the first word of the pair—that is the word that had just preceded it in the test list. Then came the question, was this accidental, or would it hold for all words thus habitually belonging together and paired as successive stimuli? Also, what would be the effect upon the reaction time in cases when such a result was obtained, and in cases in which it was not obtained? This question of the influence of one stimulus word upon the reaction to the succeeding word suggested that it would be interesting to test other possible forms of influence. What would be the possibility of influence where the two words paired were commonly connected by a conjunction, as Pork and Beans, and the first stimulus given was the second of the sub-

stantives, while the second stimulus was the first of the two substantives together with the conjunction? Again, what would be the effect upon the reaction to a given stimulus in cases in which that stimulus was preceded by a statement of a given situation of which the subject was instructed to be thinking at the time the stimulus word was given? In both of these cases there would arise the question of the effect of any such possible influence, or attempted influence, upon the length of the reaction time.

The final suggestion of a possible form of influence that grew out of these questions was of a verbal character. Suppose that you have a certain number of stimuli of one definite verbal form, nouns or verbs, followed by a certain number of indefinite or ambiguous forms—forms like boil—that can be interpreted as either verbs or nouns, and at the same time have entirely distinct meanings depending upon which interpretation is made. Then, in such cases, will the preceding definite forms influence the interpretation of the indefinite forms? If answers to these questions could be found, it would seem to make possible a much more definite and fruitful application of the association reaction as a test for criminal knowledge.

Literature

While there has been a vast amount of work done upon various phases of the association problems, yet the literature dealing with those particular aspects of the question in which we are interested is rather limited. There are two main lines along which investigation and experimentation, looking toward the practical application of the association test as a means of mental diagnosis have been developed. We will briefly review the history of each of these.

In surveying the work that has already been done in the experimental study of association and the application of the association test, it is not our purpose to go into the details of what each and every worker has individually contributed, but rather to state as briefly as possible the beginnings of the work, with the resulting main lines of development which it

has taken; together with a placing of the more important contributors in their proper historical sequence. Where details of the results of particular investigators have a definite bearing on the results of our experiments, these details will be given in foot-notes in connection with the main body of the thesis.

Francis Galton (3) in 1879, was the first man to investigate association experimentally. His experiments were entirely upon himself, and the main part of them consisted in the use of 75 stimulus words, in response to which he wrote down the words that they suggested to him. He used this same list of words at different times in four different environments. A record of the time taken in his process of association was recorded with a chronograph controlled by his finger. From these results he showed in a general way the range of association, very roughly the time required for the association process, quite clearly the greater fixity of the earlier associations. He noticed that abstract terms gave more difficulty in forming associations than did concrete terms. He also made an attempt to classify associations according to types. His three groups were: Sense imagery type, "histrionic representations," and "the imagined sound of words, as in verbal quotations." This last was frequently, "a mere parrot-like memory which acted instantaneously and in a meaningless way, just as a machine might act."

The grounds on which he fails to give the detailed results of his experiments—that "They lay bare the foundations of a man's thoughts with curious distinctness, and exhibit his mental anatomy with more vividness and truth than he would probably care to publish to the world"—foreshadowed the coming diagnostical application of the association test. He states that the object of his experiments is "to show that a large class of mental phenomena, that have hitherto been too vague to lay hold of, admit of being caught by the firm grip of genuine statistical enquiry."

This object he evidently accomplished, for the importance of the problem was almost immediately recognized by Wundt (10.) who took it up in a more careful and thorough way than

had Galton. Cattell (2) in 1887, and Cattell and Bryant (1) in 1889, published articles dealing with the subject experimentally, and from this time on there have been articles by numerous authors taking up various phases of the association problem. All of this work added greatly to the knowledge of special aspects of the problem, but it was not until 1905 that we had the appearance of the first of a series of articles detailing the results of work done by C. G. Jung (4) in establishing types of association, and later in the application of these results as a basis upon which a diagnostical study of certain abnormal forms, principally hysteria and dementia praecox, could be made.

We have stated in a general way the historical beginnings of the experimental study of association. If Jung was indebted to this source for suggestions as to the means which he would develop into a diagnostic mechanism, he was indebted to another source for the suggestion that there was any use for such a mechanism. It was from those who were interested in psycho-analysis that he gained this suggestion.

It was Dr. J Breuer, of Vienna, who in 1881 made the first definite and thorough use of the psycho-analytic method, and this upon an hysterical patient who had failed to respond to other treatment. About ten years later Dr. Breuer, together with Dr. Sigmund Freud, again took up investigations along these same lines. Freud later continued this work by himself. Jung, as a pupil of Freud, naturally became interested in this line of activity, and it was through this interest and the desire to substitute a simpler mechanism of psycho-analysis for the somewhat cumbersome one employed by Freud that he developed the association test.

Other men have used this method in trying to determine the associational complexes responsible for certain neuroses, and also have applied it in the investigation of crime (see Bibliography), but even here Jung claims priority on the grounds that he developed the method and first made suggestions towards its use in criminal investigations. Jung has also used the method in obtaining evidence of guilt in cases of theft and other minor offenses that have come up in connection

with his own regular practice. Aside from the success which attended this work in these cases and which seems to show that the association method can, and has been, successfully used under certain rather restricted conditions, we have the rather recent case recorded by Edwin W. Katzen-Ellenbogan, M.D. ("The Detection of a case of Simulation of Insanity by Means of the Association Tests." *Jour. Abn. Psy.* Vol. 6, No. 1.) A man charged with committing highway robbery was committed on the certificate of psychiatrists to the Danvers hospital as an epileptic. He had shown amnesia and was described as being in such a drunken condition at the time of the assault that he would be unaccountable for the act. By means of the association tests, results were obtained that convinced the doctor that the man was simulating. The subject later made a complete confession. But despite the success of the results in this case, the author very frankly states the limitations of the use of the method. In the closing paragraphs of his article he says:

"This example proves that psychology, in its present adolescent state, can be of assistance in problems of practical life, although it would be entirely wrong to contend that by the association test the truth of a person's statement could be positively determined. Indeed, if the association test were to be used for this purpose, I should prefer to refrain from its use altogether.

"Some writers on this subject seem to entertain this dangerous delusion, which would lead to more miscarriage of justice and errors than one could possibly imagine. Our psychic apparatus is too complicated to admit of its subjugation to such a mechanical law.

"I believe, however, that by skilful application to certain cases, the association test may prove a very valuable addition to many tests in criminal investigation work, as has been lately shown by the Bertillon methods, etc., and be of great assistance in many instances for clearing away doubts as to the truthfulness of witnesses.

"In the case under review, I worked with a man wholly

unprepared and incapable of understanding the purpose of the investigation, ignoring the facts that a hesitation, a change of word in the reproduction, were the very instances which would most convincingly tell against him. Considering even the circumstances of his knowing these facts, of his even being a psychologist, quite skilful in psychological technique, he would be equally unable to control the form of his answers and the time of associations, even to a fraction of a second. The attempt to control his answers or prepare them beforehand would incriminate him more than anything else. In this way a refusal to cooperate might be equally harmful as a result.

"The case I have reported is in many ways a model case and one would probably not find such an easy task as this one proved to be. Nevertheless, it can be said that the association test will always be of some help in advancing a criminal investigation."

I have quoted this so fully, because it seems to me to present very well the possibilities and limitations of the association test in the field of criminal investigation.

The main criteria upon which practically all workers agree in basing their determination of the existence of a submerged complex in insanity, or, and this is of more interest to us, the guilty knowledge of persons accused of crime, are lengthened reaction times, and the indications received from the reaction words themselves.

The subject to be tested is given words, as in the ordinary association test, to which he is instructed to reply with the first word of which he thinks. In this test list of words are inserted, at irregular intervals, a number of words connected with the details of the crime for guilty knowledge of which the subject is being tested. If the reaction times to these crime-associated words are longer than the average reaction times of all the other words in the list, then that fact is taken as an indication of guilty knowledge on the part of the subject tested. The retardation of reaction time with words having guilty association has been quite generally explained as the result of one of two causes. It is either due to the inhibition of the reaction as the result of the

arousal of an emotional complex in the mind of the subject, or to the conscious inhibition by the subject, because of his recognition of the incriminating nature of the first word that came to his mind. Arousal of guilty association trains may have a retarding effect upon the reaction times to words immediately following the stimulus which called up this train. The emotional excitement aroused may be sufficiently strong to carry over and cause an inhibition; in fact the emotional complex may first be aroused after the reaction to the guilty stimulus has already taken place.

As to the reaction words themselves. It is a familiar fact that when the association between words or ideas is very strong, this association finds expression almost spontaneously, and thus the subject often betrays himself before he realizes that he has even reacted. If after he has thus reacted he does realize that he has given damaging evidence, this realization generally causes a confusion and a consequent retardation in the reaction, or reactions, immediately following. Again, if several words of different nature, yet all having guilty associations with the same particular detail of the crime, are introduced at different times in the test, the subject, if he has successfully got by the first of these words will not be on the lookout for other words having the same association tendency, and is therefore the more apt to unconsciously betray himself when these words appear.

If the test series is repeated after a short interval with the instruction to respond to eaeh stimulus with the same word as used in the first test, it has been found that more changes in response are made in the reactions to the guilty stimuli than in the reactions to the non-guilty stimuli. This fact is explained as due either to the forgetting, as the result of emotional excitement attending the previous reaction, or to an attempt to remove incriminating evidence given in the first reaction.

This represents the development, and the present status of the applied association test so far as it has been accomplished by Jung and his followers. It is primarily a test based upon a comparison of the reaction times to guilty and non-guilty stimuli, together with a study of the reaction words to stimuli of the

former type. There has, however, been a more recent development along a slightly different line.

This later line of activity in the field of association experiments has looked toward the development of "Frequency Tables" in association. The first suggestion for such tables came from Gertrud Saling (7) in 1908. Incidentally to experiments confirming earlier work of Thumb and Marbe on some related problems, Saling unsuccessfully attempted to justify the hypothesis upon which those who had been attempting to apply verbal association to the field of criminal investigation had been working. She then suggested compiling tables showing the frequency with which the same response was given to the same stimulus, by different subjects. Her own compilations of this kind, being made with a class of only 34 girls from 7 to 8 years of age, were too slight to be of practical value, but served at least as a suggestion for future work. This suggestion resulted in the publication two years later of the work of Ferdinand Reinhold (6), detailing the reaction to 46 stimulus words of 30 school children from each of 10 successive grades. These results were used, among other things, to show the most common responses to each stimulus word.

It was in 1910 that the most elaborate work on frequency of association was published. This work of Grace Kent and A. J. Rosanoff (5) gave the reactions of 1,000 subjects to 100 stimulus words. These reactions were tabulated to show the variation and frequency of response of the different subjects to the same stimuli. Thus we have established, for the words used, a really comprehensive frequency table. These authors also made application of their results to insane subjects, and found more or less marked variation from the normal responses, and somewhat characteristic variations for the different forms of neuroses.

While this work of frequency in association is of immense value in its application to insanity, its value in the criminal field remains to be demonstrated. These last two workers, who have done most in establishing and using frequency tables, have entirely neglected this aspect of the practical use of their

material, while Saling and Reinhold did but little more than suggest such an application.

Bibliography

1. Cattell, J. M. and Bryant, S. Mental Association Investigated by Experiment. Mind, Vol. 14.
2. Cattell, J. M. Mind, Vol. 11.
3. Galton. F. Psychometric Experiments. Brain, Vol. 2.
4. Jung, C. G. Diagnostische Assoziationsstudien. Beiträge zur experimentellen Psychopathologie. Bd. 1. 1906. Bd. 11. 1911. Leipzig: Barth.
5. Kent, Grace—Rosanoff, A. J. A Study of Association in Insanity. American Journal of Insanity. Vol. LXVII.
6. Reinhold, Ferdinand. Beiträge zur Assoziationslehre auf Grund von Massenversuchen. Zeitsch. f. Psy. Vol. LIV.
7. Saling, Gertrud. Associative Massenversuche. Zeitsch. f. Psy. Vol. XLIX.
8. Stein, Philip. Tatbestandsdiagnostische Versuche bei Untersuchunggefangenen. Zeitsch. f. Psy. Vol. LII.
9. Wreschner, Arthur. Die Reproduktion und Assoziation von Vorstellungen. Leipzig. 1907-09.
10. Wundt, Wm. Physiologische Psychologie c. *xvi*. Philosophische Studien. i.1.

For further bibliography see Journal of Abnormal Psychology, Vol. 1, page 254.

Material—Apparatus—Method

With the purpose of first trying to find answers to the questions resulting from our preliminary experiments, and then making use of the material so obtained in a further attempt to test the real dependability of the association method as a test for guilty knowledge of crime, a suitable list of words was prepared. This list contained fifty each of definite noun, verb, and modifier stimuli. Ten of the noun stimuli were abstract terms. This part of the series was designed to test the possible influence of the verbal form of a stimulus upon the length of the association reaction time. The following word groups were chosen to test the influence of one stimulus word, or words, upon the reaction to the succeeding stimulus. (1) Ten pairs of the nature, *Music, Box*. Five of each of these pairs appeared

in each test in this order, *Music, Box.* This we called the direct form of influence. The other five pairs appeared in the reverse order, *Box, Music,* which we called the indirect form of influence. In part of the tests made the order of all these ten pairs was reversed, that in the case of individual pairs a comparison of the relative influence in the two orders might be made. (2) Ten pairs of the character of *Beans, Pork and,* which we called the *and* form of influence. (3) Ten ambiguous forms, five of which were preceded in each case by ten simple definite noun forms, and the other five by ten simple definite verb forms. In a part of the tests there was an interchange of the two groups of indefinite forms, in order that each group might come under the possible influence of both definite noun and verb preceding forms. (4) Four words, and in the last twelve tests five words, each preceded by an oral statement from the experimenter of a situation that the subject was told to keep in mind. The following is the list of words in the order in which they were given. In seven of the tests made the stimuli 1 to 10 inclusive were interchanged in position with the stimuli 20 to 29 inclusive. In the same number of cases the two stimuli 16 and 17, 35 and 36, 45 and 46, 66 and 67, 78 and 79, 104 and 105, 110 and 111, 152 and 153, 182 and 183, 192 and 193 were interchanged in position.

1. Ear
2. Goat
3. Needle
4. Lamp
5. Heart
6. Teeth
7. Spider
8. Star
9. Cow
10. Wool
11. Watch
12. Jar
13. Match
14. Pound
15. Train
16. Lundh
17. Counten
18. Beans
19. Pork and
20. Eat
21. Read
22. Use
23. Rob
24. Run
25. Lend
26. Take
27. Warn
28. Find
29. Suck
30. Pick
31. Boil
32. Sign
33. Fit
34. Stand
35. Sweeper
36. Carpet
37. Lake
38. Sympathy
39. Milk
40. Bread and
41. Green
42. Sick
43. Tiresome
44. Straw

45. Chimney
46. Sweep

47. Grow
48. Gloomy
49. Stumble
50. Provide
51. Stupid

52. Buggy
53. Horse and

54. Activity
55. Negro
56. Bright
57. Accept
58. Damp
59. Reap
60. Marvelous
61. Stork
62. Cigar
63. Imitate
64. Boisterous
65. Admire

66. Store
67. Drug
68. Ragged
69. Threaten
70. Month

71. Cheese
72. Crackers and

73. Abuse
74. Protect
75. Baby
76. Costly
77. Red

78. Salt
79. Pork

80. Gather
81. Key
82. Considerate
83. Follow

84. Eggs
85. Ham and

86. Quick
87. Hat
88. Fail
89. Despise
90. Excitement
91. Sky
92. Mattress
93. Owe
94. Dirty

95. Bacon
96. Liver and

97. Conclude
98. Recite
99. Preacher
100. Sandy
101. Prison
102. Pleasing
103. Snake

104. Box
105. Music

106. Consider
107. Slippery
108. Chocolate
109. Forgive

110. Suit
111 Case

112. Fresh
113. Handsome
114. Get
115. Peculiar
116. Hell
117. Yellow
118. Dusty
119. Shady

120. Dance
121. Sing and

122. Sincere
123. Farmer

124. Tearful
125. Advertise
126. Funny
127. Cup
128. Windy
129. Listen
130. Ripe
131. Lion
132. Muddy
133. Lawyer
134. Blue
135. Brick
136. Nice
137. Expect
138. Learn
139. Greasy
140. Door
141. Weary

142. Rolls
143. Coffee and

144. Alert
145. Possess
146. Onion
147. Go
148. Purple
149. Husband
150. Receive
151. Dark

152. Cushion
153. Pin

154. Arise
155. Sew
156. Angel
157. Difficult
158. Poor
159. Hesitation
160. Careful
161. Kill

162. Cake
163. Ice-cream and

164. Harmful
165. Approval

166.	Borrow	179.	Believe	192.	Syrup
167.	Mean	180.	Ability	193.	Maple
168.	Wisdom	181.	Rich		
169.	Feel			194.	Knowledge
170.	Policeman	182.	Coal	195.	Friendly
171.	Bashful	183.	Bin	196.	Come
172.	God			197.	Purpose
173.	Bake	184.	Tell	198.	Allow
174.	Proud	185.	Decision	199.	Feeble
175.	Ladder	186.	Send	200.	Physician
		187.	Simple	*201.	Nationality.
176.	Butter	188.	Skilful	*202.	Tom
177.	Biscuit and	189.	Apple	*203.	Organ
		190.	Conquer	*204.	Brush
178.	Unkind	191.	Dry	*205.	Shrill

*The subject was instructed in the case of each of these words to be thinking of a given situation at the time that the stimulus was given. 201. A burning clothing store. 202. Slavery times down South, before the Civil War. 203. An Italian quarter in a large city. 204. The great American desert. 205. Noon hour in the manufacturing district of a large city.

The stimuli, typewritten in upper case, were shown in an Ach card exposure apparatus placed in an electric circuit with a lip key and a Hipp chronoscope. The connections were so made that the exposure of the stimulus word completed the circuit starting the chronoscope; the reply of the subject breaking the circuit.

Each subject was instructed that upon seeing the stimulus he must react with the first word that came to him. It was emphasized that only one word must be given in response. The subject was also asked at the beginning of the test to give as detailed an introspection as possible after each reaction, as to the processes involved in following the instructions. Furthermore, throughout the experiment he was frequently asked for special introspections. Whenever there were markedly delayed reaction times he was asked to explain the cause. However, it can not be too strongly emphasized that no leading questions were asked. It was, "What was the trouble," or "How do you explain that," and not "Was this due to so and so."

The subjects used were all University of Michigan students,

taking the second semester course in general experimental psychology. A number of these were mature, careful students. The following gives the essential facts as to sex, age, and rank in the University (given in parentheses) and any other pertinent information. *G* means graduate student.

No. 1—M., 22, (4); No. 2—M., 20?, (2); No. 3—M., 22, (3); No. 4—M., 22, (4); No. 6[1]—M., 22, (4); No. 7—M., 20, (3); No. 8—M., 22, (4); No. 9—F., 20, (2); No. 10—M., 28, (G.), A Chinese student who had been in this country two years, but had studied the English language in the Mission schools of China for about eight years; No. 11—M., 23, (3); No. 12—M., 21, (3); No. 13—M., 35, (4), An Assistant in the Department of Oratory; No. 14—M., 28, (4), Negro; No. 15—F., 25, (3); No. 16—M., 23?, (3); No. 17—F., 22, (3); No. 19—M., 44, (G.), Missionary from India; No. 20—M., 36, (G.), Instructor in Mathematics at the State Normal College; No. 21—M., 22, (2); No. 22—F., 21, (3); No. 23—M., 24, (G.); No. 24—M., 30, (4); No. 25—M., 25?, (4), Negro; No. 26—M., 28, (4), Chinese, in this country eleven years; No. 27—M., 20, (2); No. 28—M., 30, (4), Nurse, graduated from McLean Hospital; No. 29—F., 25, (2); No. 30—M., 20, (2); No. 31—M., 21 (4); No. 32—F., 21, (3).

[1] No. 5 and No. 18 omitted because the experiments were not completed with these subjects.

II. DISCUSSION OF EXPERIMENTAL RESULTS

Verbal Form of Stimulus

In the tables A 1-32 will be found a summarized tabulation for each of the thirty subjects used, of all the results that have a bearing on the question of verbal forms. These tables show for each individual (1) The general average reaction time for all the successful responses to all the concrete nouns, the verbs, and the modifiers, (2) The average reaction time for the reponses to each of three verbal forms, concrete nouns, verbs, and modifiers, (3) The average reaction time for the responses to the abstract nouns, (4) for the responses to nouns used by the subjects as adjectives, and (5) The distribution of the re-

sponses, to noun, verb, and modifier stimuli, according to the verbal form of these responses, together with the average reaction time for each of these classes of responses for each form of stimuli.

We will first take up the question of whether or not the verbal form of the stimulus has any effect upon the length of the reaction time.[1] By referring to tables A 1-32 the reaction time of any subject for each of the three verbal forms used, nouns, verbs, and modifiers, can be determined. Table A, briefly summarizes the facts for the entire thirty cases. These facts show that *there is* a marked difference in the reaction time to these three different forms of stimuli. In exactly two-thirds of the cases the modifier form of stimuli gave the shortest average reaction time of the three forms used, while in almost as large a proportion (63⅓%) of cases the verb gave the longest average reaction time. This left the noun stimulus in an intermediate position as regards the length of the average reaction time. In about one-third of the cases its average reaction time was shorter than the average reaction time of either the verb or the modifier stimuli; in about one-third of the cases it was longer.

If we take the general average reactions of all of the thirty subjects to all of the different stimuli of each of the three verbal forms tested (see the general average at head of table C) we find that from this standpoint also the position of the noun is intermediate. In these actual total averages for each verbal form the verbs have the highest, the nouns the next highest, while modifiers have the lowest reaction time.

In the case of every subject, of the words given as noun stimuli at least one, and ranging from this up to nineteen, was interpreted and used as an adjective. For example, Brick—

[1] Galton, the very first experimental investigator of the association process noticed that abstract terms caused a longer reaction time than did concrete terms. This same phenomenon and the further one that there was a difference in the reaction times with the main verbal forms has been noticed by nearly every other experimenter in this field. Among other results showing this variation might be mentioned those of Cattell, Saling, Wreschner, and Jung.

Wall, Apple—Pie. The interesting thing about this fact is, that in all but four of the thirty cases in which this happened, the adjectival use of the substantive was accompanied by an average reaction time shorter than the average reaction time to the noun stimuli interpreted and used as nouns. Furthermore, this average, noun-adjectival reaction time approximated—in all but seven of the twenty-six cases—was actually less than the average reaction time to the stimuli given as adjectives and adverbs. Moreover, in three of the four cases in which the noun-adjectival average reaction time was longer, rather than shorter, than the noun average reaction time, the modifier average reaction time was also longer than the noun average reaction time. If one cares to look at the same facts from a slightly different angle he may turn to Table B-3. Here he may make a comparative study of the average of all the reaction times in which any given noun has been used as a noun, and the average of all the reaction times in which this same noun has been used as an adjective. It will be found that the latter average is shorter in all but one case out of twenty. These facts show that a word commonly and frequently used both as an adjective and as a noun, when used as an adjective has a reaction time that corresponds to the reaction time of an adjective, and when used as a noun has a reaction time that corresponds to the reaction time of a noun. This further emphasizes the fact noticed in the more general study of the tables—that there is a real difference in the length of reaction times to noun and adjective stimuli.

The results of the experiments having shown that there is this difference in reaction times connected with the different verbal forms of the stimuli, there remains the question of the possibility of its explanation. Why does a noun stimulus give us a longer reaction time than does a modifier stimulus? and why does a verb stimulus give us longer reaction time than either a noun or a modifier stimulus?

Let us ask what are the main lines of association with each of these three verbal forms. Take for instance any noun, as cow. Under the conditions of this experiment the reply must

be a single word. What single words might express that which might be suggested by cow? You might think of something the cow does—eat, graze, etc.; of something done to the cow—drive, feed, etc.; of something the cow is—large, clean; of something connected with the cow—stable, milk; or any of the co-ordinates, sub-ordinates,, or super-ordinates with cow. You have in all these cases the noun as the actor, verb response; the object or thing acted upon, verb response; the thing described, adjective response; or the thing conjoined or ordinated with some other object, noun response. In the same manner take a verb—say, eat. It may be the reply will be the object of the verb, that which is eaten, noun response; or the object eating, noun response; the manner in which the eating is taking place, modifier response; or again an ordinate, verb response. With an adjective among the main possibilities are an object described, noun response; or one of the ordinates, adjective response.

Which of these main characteristic reactions possible for each of the verbal forms would seem the easiest for that form? It would naturally appear that the word to be responded to any stimulus would be the one that would most naturally and logically follow after the stimulus word. We are continually expressing ourselves in speech and in writing. Even our unexpressed thoughts tend to be carried on in verbal form. In all our use of language there is a natural sequence, probably of thought, and quite clearly of words.

In the English[2] language this *habitual* order is *always* an

[2] Herbert Spencer (Philosophy of Style) might not be willing to admit that the natural thought order was adjective—noun, but rather the reverse, noun—adjective; yet this does not really affect our problem, even should we grant that it is true. We are dealing with the question now of the habitual word sequence in language. However, one other fact brought out by our studies might have a direct bearing on the validity of Spencer's contention that the normal thought order is noun adjective. For instance, we might ask, if this were true, then why, the subject being given noun stimuli, did we get such a small percentage of adjective responses?

If one were interested in the question of whether a noun-adjective order were more economical than the adjective noun order, he might

adjective noun order. True, even in the English language we occasionally have the inverted order, but the object of this inversion is emphasis, and the reason it emphasizes is because the elements attract the attention by being *out of* their natural, or *habitual order*. Likewise that which naturally follows a verb is an object, or a modifier, and that which naturally follows a noun is a verb.

It would seem, therefore, quite reasonable to suppose that association under the conditions of this experiment would follow the natural sequence of thought and language and that as a general rule with a noun stimulus you would have your reaction in the form of a verb; with a verb stimulus the response would be in the form of an object, noun or pronoun, or of a modifier; with an adjective stimulus the predominant form of response would be nouns. Do the experimental results bear out this line of reasoning? Only partially. As shown in Chart A_b both verb and adjective stimuli show, as we would expect, a very marked dominance of noun responses, while, contrary to the natural expectations, the noun stimuli show an equally marked dominance of noun responses.[3]

This partial disagreement of our facts with what we would expect from the natural sequence of language may, I think, be partly explained on the following grounds. Contrary to all ordinary experience, we are here given a stimulus word in isolation from all else. In most cases, immediately upon its appearance its isolation disappears—an association has taken place. After this has taken place the result must be expressed

well find it worth while to test a number of French subjects with a given list of noun and modifier stimuli, to see whether he would get comparatively shorter reaction times than with English speaking subjects.

[3] These results are contrary to those obtained by Saling and by Wreschner, experimenting independently. Saling found that adjectives and adverbs of time and place, as well as nouns, were generally associated with words of the same class. Wreschner also found that the most common reaction for an adjective stimulus was an adjective, the most common reaction for an abstract stimulus was an abstract term, and that such "symmetrical" reactions were commonest with rapid reactions.

Our results show marked dominance of noun responses to all three forms of verbal stimuli with more noun responses to adjectives than to any other form.

by a single word. Psychologically the expression in a single word of the association of which an isolated noun becomes a part is distinctly different from such an expression of the association of which an isolated modifier or verb has become a part.

The noun, ordinarily, is concrete, an entity. If the stimulus man is given, the subject immediately gets a complete idea—man. It may be a given man in a given situation, man in general, some particular type of man. Whichever it is, it is complete, it is a whole. What is the subject going to reply? He may reply with a descriptive term, or he may reply with some other part associated in this entity. Whatever he replies he must move away from his completeness to do it. This means a choosing from among possible replies, an effort to pick out some one. Moving away from completeness also means unpleasantness. All these factors naturally tend to lessen the probability of any natural sequence of verbal order being evidenced in the response which finally comes. Likewise these same factors tend to lengthen the reaction time.

The modifier, on the other hand, is the exact opposite of the noun. It is incomplete. It means nothing of itself. When the modifier stimulus appears, because of the incompleteness there is unpleasantness until the reaction takes place and completeness ensues. Thus the very incompleteness of the modifier is a goad to action. Moreover, the very same action that removes the incompleteness, at the same time usually supplies the necessary reaction word. The word dark, of itself, has no sufficient meaning, but dark something has. It is the something that makes the meaning and the completeness. At the same time it is the something that furnishes the reaction. This means the persistence of the natural linguistic sequence in the reaction word. And as a result of these things comes, of course, a shortened reaction time.[4] Thus the difference in the length

[4] Cattell (3) found that with the two subjects with whom he worked it took longer by 111 and 146 sigma respectively, to find an object than to find a subject for an intransitive verb, "the mind moving logically in the latter direction." He also made some experiments on a single subject and found that it took twice as long to recall a foregoing as a following month.

of the reaction times between noun and adjective stimuli, as well as the lack of the natural verbal sequences in the responses to the former and the presence of it in the responses to the latter, lies in the fact that there is a distinct psychological difference in the expression in a single word of the association that follows the perception of an isolated noun, and that which follows the perception of an isolated modifier.

That there exists the same sort of psychological difference between an isolated noun and an isolated verb is so evident that it will be unnecessary to go into a detailed explanation of it. The line of reasoning here advanced also receives strong support from the introspections of various subjects. In judging these introspections it should be born in mind that they are in no sense the result of leading questions. They are simply the answer to the question "Why were you so long?"[5] Or, and this is equally often the case, they are the spontaneous expression of something that the subject has so keenly felt that he has needed no question to bring it out. Therefore, what this introspective material has lost in volume, it has, I hope, more than made up in being truthful and unbiased.

These first few introspections bear evidence of the incomplete character of the modifier and the verb.

No. 1. Harmful—Savage, 3.067.
"Picture of the Savage automatic. Took me so long because was hunting for something harmful."
No. 13. Harmful—Insects, 1.158.
"Think that I thought of what." (Harmful what?)
No. 4. Use—What, 5.500.
"That didn't bring anything at all. Couldn't think of anything that use."
No. 13. Warn—Warner, 2.549.
"I thought of warn who? warn what? But couldn't think of anything. Then the other came in."
No. 13. Find—Me, 1.582.
"Thought of find what? and nothing came but me."

[5] It is often in the longest reactions of a particular kind that the processes involved become most apparent.

No. 19. Find—Gold, 1.097.
"Process of deliberating—find what?"
No. 19. Expect—Praise, 1.120.
"Case of trying to think of something that people might expect."
No. 16. Threaten—Man, 1.368.
"Thought of who could threaten—man could."
No. 16. Abuse—Man, 1.698.
"Thought of abuse, and then had to think of something to abuse."

The following example throws light upon the unpleasantness—pleasantness aspect of the incompleteness and then the completeness of a verb stimulus.

No. 13. Threaten—To kill, 7.270.
"Was just conscious of searching. Conscious of strain of trying to get something to make sense. Also wondered if clock was running over ten seconds. Was relieved to think had found something to make sense."

The next two give an interesting contrast between nouns and adjectives. The third shows the importance of the natural linguistic order while the fourth speaks for the *completeness* character of the noun form.

No. 4. Costly—What, 1.038.
"Just give me a word—don't mean anything. Give me a noun and it means something; an adjective or a verb simply means a question."
No. 19. Farmer—Horse, 1.607.
"Word farmer there does not form phrase like those words that go to make up compound words, or as adjectives do. Takes a little longer to think of something that goes with farmer."
No. 19. Purpose—Good, 1.506.
"Good purpose. Couldn't think of any word to follow purpose. When I have to turn it around that way it causes delay."
No. 22. Lake—Whitmore Lake, 1.523.
"Thought of just lake in general at first."

No. 4 and No. 7. These two subjects very frequently gave as a response some interrogation. An interrogative response

following a stimulus word is the most direct and clear statement of the nature of the mental process started by that stimulus. The fact that in these two cases there were so many more of this kind of response to verb and modifier than to noun stimuli, emphasizes the *incompleteness* character of the former as contrasted with the *completeness* of the latter. The per cent of these interrogative responses were for No. 4; concrete nouns 7½ per cent, verbs 30 per cent, modifiers 14 per cent, abstract nouns 0 per cent. For No. 7; concrete nouns 0 per cent, verbs 6½ per cent, modifiers 4 per cent, abstract nouns 10 per cent.

All the evidence so far seems to support the theory that modifiers and verbs are alike in the nature of the psychological process which they stimulate, while the noun is different from either of them. If this difference between noun and modifier stimuli is used to explain the greater length of reaction time with the noun stimuli as compared with the modifier stimuli, are we not to expect, on the same grounds, that noun stimuli would have a longer reaction time than verb stimuli, and that the latter would have a reaction time corresponding to the reaction time of modifier stimuli?

This, indeed, would be the logical conclusion from the facts so far presented. However, there is one important way in which verb stimuli differ from both noun and modifier stimuli. The verb stimuli have a greater percentage of distribution of responses than have the other two forms of stimuli. By the percentage of distribution of responses of a stimulus is meant the per cent of different responses which that particular stimulus called out in the entire number of subjects tested. For instance, with the stimulus Provide there were 14 different reaction words given by the 30 different subjects. The percentage of distribution was then, in this case, 46⅔.

In Tables B-1, B-2, B-3, we have respectively the verb, modifier, and noun stimuli together with their percentages of distribution of responses. In each of these tables the stimuli are arranged according to the length of the average of all the reaction times to the individual words. Glancing down the columns of percentages of distribution we find this relation holds for

each of the three verbal forms—the majority of the high percentages of distribution of responses are in the upper third of the column, the majority of the medium percentages are in the middle third of the column, and the majority of low percentages are in the lower third of the column. In other words, with a gradual decrease in the length of the average reaction time we find a corresponding, though not a uniform, decrease in the percentage of distribution of responses.

A further study of these three tables shows that in nearly all cases in which five or more subjects have responded with the same word to a given stimulus, the average of the reaction times for these responses is less than the average of the reaction times for all the other responses to this stimulus. In the case of verb stimuli this is true in 77½ per cent of the 40 cases, with an average saving in reaction time for each of the 40 cases of 239 sigma; with modifier stimuli it is true in 85 per cent of the 54 cases, with an average saving of 319 sigma; with concrete nouns it is true in 100 per cent of 23 cases, with an average saving of 327 sigma; with abstract nouns it is true in 100 per cent of 4 cases, with an average saving of 242 sigma.

A small percentage of distribution of responses really means that a large number of people have the same association complex aroused by a given stimulus; also that they tend to express the common complex by the same word. Windy is probably (at least as far as our results show) more commonly associated with day than with any other word. The fact that so many people associate these, or any two words, together means that any individual who has that association at all has it very frequently. He continually hears other people using it, and is continually using it himself. Thus when the stimulus word windy is given the response day will be apt to come quickly for two reasons. First, because it is the habitual association and those association paths most frequently used are the ones most readily used. Secondly, because of the dominance of this association no other associations have a chance to start to form. The following introspections throw some light upon this problem, and also show that with those stimuli with which there is possible

a large number of responses we do actually get a lengthened reaction time, over the average of that class of stimuli.

No. 20. Ripe—Berry, 2.748 (1.648)[6]
"Didn't know what to apply ripe to, are so many things."
No. 20. Fail—Exam., 2.039 (1.839)
"Kept saying, fail, fail. Why there are so many things you can fail in. Then thought of exam. as the most appropriate thing for this occasion."
No. 22. Pleasing—Joke, 1.217 (.981)
"More the idea of story than of joke. So many pleasing things to think about, couldn't settle down down to any one."
No. 25. Nice—Candy, 1.371 (.749)
"Thought of about two dozen things."

If we look at the matter introspectively for ourselves, I think we shall feel that, at least so far as modifiers and verbs are concerned, there will be little doubt as to which we more habitually associate with certain things.

In Table C we have verb, modifier, and noun stimuli respectively, together with their general averages arranged according to their percentages of distribution of responses. Grouping in each of the three forms of verbal stimuli all those words whose percentages of distribution of responses falls between 80 and 100 per cent, 70 and 80 per cent, 60 and 70 per cent, 50 and 60 per cent, 40 and 50 per cent. and 10 and 40 per cent and averaging the total average reaction times for each group (Table C), we find that with but three exceptions the average of each lower group of percentages of distribution of responses is lower than that of the group just above it. In the three cases in which exceptions to this rule are found, one of the two groups compared contains only a very few stimuli averages, viz., 3, 4, and 6 respectively. Probably with a sufficient number of stimuli averages in each group, to make the situation at all representa-

[6] Numbers in parentheses are average reaction times for the particular class to which the given case belongs. In this particular example it is the average reaction time of this subject for all the noun reactions to adjective stimuli.

tive, the rule would be absolute. This serves, then, as further evidence of the influence of percentages of distribution upon lengthening reaction times.

The chief significance of the facts presented in Table C is expressed driagrammatically in curve C_a. This curve shows that there is a very close similarity between the percentages of distribution of responses of noun and modifier stimuli. The curve for these two forms very closely approximates on the ends, and in both cases their apex falls in the central region of 50. On the other hand the verbal curve shows a widely differing distribution. With verb stimuli the maximum diversity of response is higher than that of either the nouns or modifiers, while its minimum is considerably lower.

We have, then, from the evidence furnished us by the introspections and by these variously tabulated results the following specific facts:

(1.) Nouns and modifiers have very nearly the same range of percentages of distribution of responses (for definition of percentage of distribution of response see page 22), but are unlike psychologically.

(2.) Modifiers and verbs are alike psychologically, but verbs have a very much higher percentage of distribution of responses.

(3.) High percentages of distribution of responses are accompanied by lengthened reaction times.[7]

[7] As bearing on the particular point in question a part of the results of Wreschner are of especial interest. He repeated the free association test sometimes on as many as 8 different occasions (always with at least a week's wait between each series) with the same stimuli words and the same subjects. With the 3,338 results that he obtained he found that with adjectives there was the greatest tendency for the same subject to reply with the same word on the different tests, and that with abstract nouns there was the greatest diversity of response. If we consider in this connection the further fact that with his adjective stimuli Wreschner got reaction times ranging from 1,709 sigma to 2,328 sigma, while with his abstract nouns his results varied from 2,028 to 3,415 sigma we will find support for the view that long reaction times are connected with diversity of reaction.

Wreschner further finds that while with the first two or three repetitions of the reaction word there is a retardation in the reaction time, this is followed later with an increasingly great diminution of that time. He suggests that the retardation is due to the occurrence to the subject's mind of new responses, while the acceleration is due to the recurrence of the old response. If his suggestion be true, then we have reason to say, in terms

(4.) The character of completeness of which nouns partake tends to retardation of reaction times, while the character of incompleteness which characterizes modifiers and verbs tends to decrease the length of reaction times.

From which we may conclude that the difference in the length of reaction times between nouns and modifiers is due to the psychological difference in character of reacting, under the conditions of this experiment, to an isolated noun, and to an isolated modifier stimulus, while the greater reaction times of verbs is due to the psychological influence of the possibility of reacting in a large number of different ways, as evidenced by a high percentage of distribution of responses.

Other Factors Influencing Reaction Time

The discussion and facts just given show that the verbal form of the stimulus has a very decided effect upon the length of the reaction time. There are other factors at work, however, whose influence, while not so constant and calculable a force, is of decided importance in the consideration of the question of the length of reaction times. Since, for reasons above pointed out, it was decided to rely upon spontaneous, or at least, unguided introspection, it was impracticable to compile any concise tables in regard to these other influences. However, the cases cited as examples of each such influence are sufficiently numerous

of the theory that we have advanced, that the occurrence of the new responses tends to inhibit the old response, but that since this response has once been made it has increased strength and, *in time,* overcomes the inhibition.

Also in close keeping with this theory is the fact that controlled associations—other conditions being equal—are shorter than free associations. In other words, the same result in regard to length of reaction time is obtained whether the limitation of the number of possible associations is natural (the inhibiting of other associations by the strength of some one association) or artificial (the limiting of the number of possible associations by a set condition governing the nature of the reply). Wreschner found, not only that this was true, but that the smaller and more definite was made the field of possible response, the shorter the reaction time became. For instance, the naming of a country which contained a given city required an average reaction time for the subjects with whom he worked of 1,535 sigma, while the naming of any city required 1,665 sigma; naming the author of a given book required 1,737 sigma, naming any book of a given author required 1,968 sigma.

and sufficiently striking to remove any doubt as to their real power.

Of these other influences affecting length of reaction times, one of the most important is the tendency of the subject to visualize. The results of our experiments, while they can not be definitely tabulated, indicate that as a general rule the coming, with the appearance of the stimulus, of a visual image tends to retard the reaction.

There are two general classes of visual imagery. There is a simple imagery, where nothing appears in the picture save the isolated image, generally of the object representing the stimulus word. There is a complex imagery, in which the picture represents a complete situation. In either case the natural result is retardation of reaction time. The coming of the simple image necessitates the finding of some word, other than the stimulus word to represent the image, or some part of it. The complex image necessitates, either the extremely difficult task of finding a word to stand for the total situation presented by the image, or, and this is more often the case, the selection (and selection involves time) of some part of the presented picture and the replying with the word suitable to this selected part. Furthermore, the very fact of the natural image response often tends to inhibit the coming of any word response.

The following examples illustrate the influence of both the simple and the complex types of imagery. The comparison of the reaction time of each particular stimulus with the average reaction time for stimuli of that class (given in parentheses) clearly shows the retarding effect of the visualization.

No. 2. Ear—Lobe, 4.764 (2.688)
"Image of ear comes almost at once. Took some time to pick out what was going to say."

No. 3. Activity—Mental, 1.667 (1.030)
"Image of a student at a student's table. When I see those images the word don't come."

No. 3. Prison—Chains, 3.075 (1.324)
"Nothing came up. Had a vague picture of the prison first, but nothing to express it."

No. 13. Angel—Cake, 2.123 (.985)
"Saw an angel standing in space, twenty or thirty feet up in the air. Couldn't get any word. Kept thinking angel, till the word cake dropped in, then the angel went."

No. 4. Lamp—Brazier, 3.093 (1.305)
"Just saw it straight ahead. Kept saying lamp, lamp. Didn't anything else come, that's all."

No. 22. Farmer—Hay, 1.707 (1.096)
"Picture of a farmer with a big straw hat and hay in his mouth. Had to look him over to find what to say."

No. 23. Ragged—Pants, 2.172 (.879)
"Didn't know whether to say boy, pants, or street urchin. Had a picture of a street urchin standing on corner. Pants the emphatic part of it."

No. 28. Greasy—Dishes, 2.315 (1.048)
"Saw Hamburger (lunch counter) over here—couldn't get *one* word to come."

Instances such as the two following may indicate that visual imagery is less apt to cause retardation with modifier stimuli, where the imagery may suggest the response, than with noun stimuli, where the image is often the picture of the stimulus word itself.

No. 2. Green—Grass, 1.212 (1.948)
"Saw blades of green grass."

No. 2. Watch—Gold, 7.033 (1.749)
"My own watch suspended in space. No descriptive word came to me."

On the other hand with two or three of the subjects there seemed vague indications that the imagery was an aid rather than a hindrance to the forming of the verbal association. The conditions were not such, however, as to give any clear evidence that this was the case. The subjects giving such indications were individuals having a narrow association range. That is, words did not seem to call up other words. In such cases, it may well be that the image aids the reaction by suggesting an association that would come about in no other way.

This all raises the question of whether the image comes after the verbal association, thus expressing it; or before the verbal

association, in which case the imagerial association is expressed by the verbal. If, as in a few cases, the individual gets his cue for the verbal association from his visual image, then the appearance of the image before the verbal association, is an aid to the association, otherwise it is a hindrance and causes retardation in the reaction time. It is well nigh impossible for the ordinary subject to discriminate truthfully the sequence of imagerial and word association. Often the subject, especially where the reaction has been very short, is at a loss to know whether the image came before or after the actual reply. Hence it is impossible to draw more than very broad generalizations upon this point.

Oftentimes a stimulus word half calls up a number of ideas, thus causing a general feeling of confusion. This is opposed to short reaction times.

No. 8. Red—Paper, 2.193 (1.326)
"Very confused—most confused have had yet. Was a number of things seemed on the point of saying. One was red sock. Don't remember any other. Seemed as if would have to pick one. Looked at the card in front and said paper."

No. 29. Hat—Picture, 2.439 (1.390)
"I want a new hat—and Easter, all those things came up together."

No. 32. Tiresome—Work, 1.846 (1.467)
"Confusion, muddle—didn't get anything."

Closely linked with confusion as a cause of retardation is the case in which the stimulus word calls up some situation or idea that it is difficult to express in a single word.

No. 13. Negro—War, 3.026 (1.470)
"Thought in general of negro servitude, but couldn't get any word to express the idea."

No. 20. Poor—Old, 1.836 (1.410)
"Poor suggested something not up to standard. No particular word for it. Standardized that particular suggestion by old."

No. 20. Find—Give, 3.796 (1.617)
"Word reminded me instantly of article read in newspaper a few days ago of a fellow who found a valuable purse. No word to represent this, until thought of what he ought to do—give it back."
No. 21. Mattress—Bed, 1.442 (1.002)
"Some trouble there. Got the idea of house first. Idea of house as a whole; living apartment, or something like that—not the word house."
No. 21. Music—Hall, 4.453 (.888)
"Was confused there. Started to think of English class, teacher, and certain situation all together. Had to go from that because was too much."

Often times there is not a mere suggestion, but a marked tendency for two or more associations to be formed. Each one of these serves as a natural inhibition to the other and a delayed reaction time is the result. This tendency is often characterized introspectively as a "struggle."

No. 13. Costly—Dress, 3.172 (1.077)
"Was another word crowded in there. Wasn't so clear. Think it was apparel. Thought it, but Couldn't speak it—couldn't formulate it."
No. 13. Possess—Wealth, 2.083 (1.466)
"Were two or three ideas trying to get in. One almost thought had, but didn't. Was searching. When search the same idea never comes back again."
No. 13. God—Help, 1.899 (1.115)
"Just a sort of struggling again. Three other indefinite impulses that was conscious of. Seems to me now that bless was one of them."
No. 19. Prison—Cell, 1.424 (1.005)
"Bar and cell both struggling for expression."
No. 19. Weary—Man, 1.026 (1.005)
"Word wanderer coming in to interfere with it."
No. 19. Harmful—People, 1.917 (1.005)
"Thought of word man too. More or less of a struggle for the expression of the two thoughts."
No. 20. Pick—Berries, 2.155 (1.839)
"Saw an old strawberry patch at one end of the garden. Seemed to suggest almost simultaneously

another thing. We used to go off to the hills to pick cherries. Couldn't think whether to say cherries or berries."

Two very related groups of introspections bearing on the cause of long reaction times are those that give as the cause of the delay the fact that there is a "Blank"—no association comes, and those that say the association comes only after a process of "searching."

Blank:

No. 13. Tiresome—Laboratory, 3.826 (1.403)
"Why so slow; my mind a blank. The most tiresome thing I could think of was a laboratory."

No. 6. Heart—Flesh, 2.322 (1.011)
"Can't figure out how I got that. Sort of a vague search you might say."

No. 8. Star—Player, 2.117 (1.203)
"Word didn't suggest anything at first."

No. 9. Skilful—Ability, 5.808 (2.328)
"I couldn't think of anything. Just can't. My mind is a perfect blank this morning."

No. 17. Star—Moon, 5.767 (2.642)
"Didn't think of anything."

No. 24. Goat—White, 1.735 (1.100)
"Just nothing—just blank. Just isolated and then realization that it was isolated."

No. 30. Conclude—Time, 2.135 (1.079)
"Don't know why said it. Couldn't think of anything."

No. 32. Tearful—Girl, 9.464 (1.467)
"Absolute blank! Didn't get a single thing. Then saw a particular girl crying."

Searching:

No. 13. Boisterous—Waves, 1.728 (1.077)
"Just searched until the word came. About three things started to come in before, but didn't come very far."

No. 13. Gather—Wool, 2.771 (1466)
"Was searching for a word and finally that came. Thought wool gathering."

No. 13. Receive—Help, 1.710 (1.466)
"Just a searching there; couldn't get anything tangible to say."

Occasionally, also, the length of the word seems to have an influence upon the length of the reaction time.

No. 16. Consideration—Ation, 2.565
"Was a longer word. Had to look to see what it was."
No. 22. Sincere—Friend, 1.196 (.981)
"Stop to read test word more carefully because was long. Didn't want to make mistake as I did on imitate."

Finally, we see that there is some evidence, also, of the influence of emotion and of conscious inhibition of the natural association.

Emotion:
No. 25. Excitement—Ran, 1.133 (.896)
"Got a picture of a riot in which the excitement ran high. Lots of people all mixed up. Feeling that didn't want to get hurt. Then thought of place where was last year. Thought that I was going to get killed. Was on a high dark R. R. bridge near a station. Thought was going to get thrown off. Found myself there again."
No. 29. Tearful—Me, 1.960 (1.286)
"Was conscious of a particular condition about three years ago."
No. 29. Decision—Hard, 1.397 (1.851)
"Called up a certain unpleasant situation before I spoke. Was about three or four years ago." (This the same situation as in the preceding case.)
No. 29. Policeman—Jump, 2.384 (1.533)
"Feeling of fear, just as if saw a policeman coming. Have a kind of awe of them yet. Used to be afraid if saw one a mile off.

Conscious inhibition:
No. 13. Admire—Dewey, 2.423 (1.466)
"First thing that popped into my head was me. That I rejected. Searched around for something more suitable. Think I said Dewey because have been reading a book about Dewey and the Spanish war to my boy."

No. 13. Hell—And damnation, 1.870 (1.470)
"Felt that shouldn't say it."
No. 13. Suck—Mother, 2.829 (1.466)
"Thought that was a little rank. Tried to think of something else. Saw an infant doing it."
No. 15. Lawyer—Liar, 4.063, (1.555)
"Thought of that before, but tried to think of something else."
No. 20. Take—Steal, 3.783 (1.617)
"I started to say leave and it flashed on my mind that that was not appropriate as had already said it once. Searched for a new word.
No. 22. Purple—Dress, 1.798 (.981)
"Didn't want to say it. Hesitated after the word came."
No. 27. Suck—Eat, 1.833 (1.057)
"Saw baby at mother's breast. Didn't like to express it."
No. 29. Pleasing—Me, 3.146 (1.286)
"Didn't say me as soon as came—Didn't want to."
No. 31. Suck—Fruit, 1.625 (.755)
"Think lemon the first thing that came. Sounded foolish."

When two words are frequently or habitually used together, they become the same as one word. Then the first part is almost sure to call up the second. We have a vocal motor habit established. Practically no thought is required. After the vocal processes commence their action on the first part of this combination they unconsciously continue it until the entire combination (which includes the second word) has been formed by them. Thus we might expect as the result of this motor response a marked reduction in the reaction time.

No. 7. Friendly—Man, .707 (1.035)
"Just popped right out."
No. 13. Accept—My thanks, 1.139 (1.466)
"Came into my mind like a flash. That is sort of a pet phrase of mine in closing a business letter."
No. 13. Farmer—Friend, 1.032 (.985)
After the subject had replied a very surprised expression came over his face. He said, "I didn't think at all, feel as if alliteration had something

to do with it." In another introspection he says, "Have a tendency to use a good deal of alliteration in my writing. I find it in my papers after I have written them."

No. 13. Greasy—Grind, .846 (1.077)
"Nothing there before I said it, but remember now of having said that in some connection a day or two ago."

No. 19. Learn—Books, .883 (1.230)
"Nearly cut it off in the middle because I saw that it was not the proper expression. Was an expression that when I used to teach school twenty-five or thirty years ago was quite common with the parents."

Tests of Forms Influencing Reactions

Direct and *Indirect* Forms

Having finished our discussion of the main point in our inquiry—the question of the causes of variation in the length of reaction time—we come now to the question of the effect of control or influencing factors upon reaction and reaction time. Taking the various forms suggested, in the order in which they were mentioned in the introduction, we will first consider, in their various aspects, the importance of the *direct* and the *indirect forms of influence*.

In regard to these two forms we have three questions to consider. (1) Is one form more successful than the other in exerting influence over the response to the second of the two stimuli? (2) Do we find any difference in the length of the reaction time when we have the two different forms of influence? (3) How do the reaction times of each form of influence compare with the general reaction times of the different subjects?

In the finding of answers to these questions we will refer to tables D-1 and D-2. The results there presented may be looked at in two different ways. We may study the per cent of the apparently successful control and the relation of the reaction times of the two forms in each individual case of the thirty cases tested, and we may compare the reaction times and per cents of success of each of the ten pairs throughout the cases in which

they each appeared in the *direct form,* with those cases in which they each appeared in *indirect form.* In regard to this latter method it is to be regretted that there was not a more even distribution of cases for each of the two forms. However, since the results so closely agree anyway, it would probably make no difference in the general conclusions if the division had been more even. As it stands now, each pair was used in one form only seven times, while it was used in the other form twenty-three times.

Summarizing the results of Tables D-1 and D-2 according to the first method we find that out of the five pairs that appeared in *direct* form for each individual of the thirty individuals tested, there was an average of $2\frac{12}{30}$ pairs in which the reaction to the second stimulus of the pair was the same word as the first stimulus of the pair (that is a successful influence); while out of the five pairs that appeared in *indirect* form for these same thirty individuals the average, for the same results, was $2\frac{11}{30}$ pairs. The distribution of the number of successful controls by both *direct* and *indirect* forms over the thirty cases is shown by curve D_a.

Out of the thirty cases there were 6 in which one form or the other was entirely unsuccessful. This leaves 24 cases in which we can compare the average reaction times of the successes of the *direct* and *indirect* forms. In 17 instances, or 70⅚ per cent of these 24 cases the reaction times of the successful *indirect* forms were shorter than the reaction times of the successful *direct* forms. But if we spread the saving in reaction times of the *indirect* over the *direct* forms over the entire 24 cases we will find that it amounts to only 139 sigma per case.

Summarizing the results of the same tables according to the second method mentioned, we find that there are 7 of the 10 pairs appearing throughout the 30 cases that have a greater percentage of successes when appearing in their *direct* then when appearing in their *indirect* order. But the excess of influence of *direct* compared with *indirect* when distributed over the 10 pairs amounts to only 7 per cent per pair.

There are 6 pairs out of 9 (one pair, No. 5, having no influence in the *direct* form) in which the average successful reaction time of the pair is less when it appears in its *indirect* form than when it appears in its *direct* order. But the total saving in time of the *indirect* over the *direct* order amounts to an average of only 75 sigma for each of the 10 pairs.

No matter in which of the two ways we look at the results we find that the same thing holds. In regard to percentage of successes we find, that both for the different pairs in the individual cases, and for the same pairs throughout the 30 cases, the *direct* has an advantage over the *indirect* form. This advantage, however, is so slight that it is of no practical significance. In regard to the length of the reaction times we find, both for the different pairs in the individual cases and for the same pairs throughout the 30 cases, that the *indirect* has an advantage over the *direct* order. But here, again, this advantage is too slight to be taken as indicating any vital difference between the two orders.

Therefore, from these results we may conclude that the *direct* and *indirect* forms are practically on a par, both as regards the influence of the first stimulus of the pair upon the reaction to the second stimulus of the pair, and as regards the length of the reaction time of those cases where the influence has been shown. However, curve D_a would seem to indicate that in respect to the evenness of distribution of successful influence the *direct* form has the advantage. There are fewer pairs of the *direct* order that have an extremely high or an extremely low number of successes. Twenty-one cases out of the 30 have either 2 or 3 successes; only 6 have less than 2, and only 3 more than 3 successes. With the *indirect* form, on the other hand, there are only 10 cases out of the 30 that have 2 or 3 successes, while there are 11 having less than 2, and 9 having more than 3 successes.

In answer to our third question Tables D-1 and D-2, show that with the *direct* form of influence the average of the reaction times in those cases in which the influence worked are less than the general reaction times of the respective subjects

in 75 per cent of the cases and that the *indirect* averages are less than the general averages in 96 per cent of the cases. Our previous comparison of the relation of the reaction times of successful *direct* and *indirect* forms indicates that the difference of 21 per cent here shown, is of no significance. The one thing that really is significant is the fact that in a considerable majority of cases the average reaction time is less with the successes in these control forms than the general average reaction time for all other forms.

And Form

In testing the ***and*** form of influence we have this problem: If we take two substantives that are commonly joined together by the conjunction "and" and use the second of these as a first stimulus, and immediately following use the first substantive together with the conjunction "and" as a second stimulus, then will the response to the second of these two stimuli be influenced by the first stimulus and the conjunction "and" that has been added as a part of the second stimulus? In tabulating the results each case in which the response to the second of the two stimuli was the first substantative used as a stimulus was called a case of successful influence.

There also arise two questions regarding the lengths of the reaction times in these cases. Will the average reaction times of the successful influences of each pair be greater than, or less than, the average reaction times of the unsuccessful influences? What will be the relation of the average reaction time of the successful and the unsuccessful influences in each of the thirty subjects to the general average reaction time of these subjects.

By examining Table E we find that there is considerable evidence that the ***and*** form of influence does exist, although a glance at curve E_a will indicate that the range of the successful influences for the different pairs of stimuli is very wide, while curve E_b shows an equally wide variation of successful influence when looked at from the individual standpoint, although the average number of successes per individual is relatively high—7.33 out of a possible 10. This wide variation of suc-

cessful influence together with the facts given in Table E_c, showing the distribution of responses in the cases where the influence was unsuccessful would lead one to believe that of the two things—the preceding stimulus word and the conjunction "and" which follows the second stimulus word—it is the latter which plays by far the greater part in the control of the association to the second stimulus. It is apparently the conjunction "and" that influences the association, and that influence extends beyond the limits of that which we postulated here as a successful influence. What the "and" really did in most of the cases was to call up the substantive that was habitually associated by the individual subject with the substantive to which the "and" was connected as stimulus. The most striking example of this is in the pair No. 2 Milk, Bread and. In selecting this combination as one of the ten pairs to be used I considered that I was choosing words that would be immediately associated together by practically everybody. The reason for this was, probably, that all through my own life bread and milk had been strongly linked together, while bread and butter, due to individual taste, had not. But my experience evidently had not been the experience of the majority of the subjects used in this experiment, for in this particular case there was an actually greater percentage of the reply "Butter" (43 per cent) than of the reply "Milk" (40 per cent). The introspections of the subjects also bear out this idea that it is the conjunction "and" plus the experience of the individual subject that is responsible for the reaction. No. 8 for the stimulus "Bread and" reacted with "Butter" and gave the following introspection, "Saw a glass with a piece of bread sticking in it. Don't know why on earth didn't think milk, but thought butter. Didn't have any inclination to think milk." No. 4, who had been ill for several days just preceding the experiment reacted to the same stimulus with the word "Water" and said, "That's what I've been eating for a day or two." Again with the pair "Pork and," one of the three pairs having the highest percentages of successes, we still find introspective evidence of the same character as that just given. No. 14 replied "Beans" and said, "Just came naturally.

Anybody who works in a hotel or anybody who orders it—it would be that way." Right along this same line of thought is the introspection of No. 20, who also replied "Beans." He said, "I couldn't have thought of anything else. Didn't think of the preceding word at all. That's what you see on the menu card, always." No. 16 replied "Beans." His introspection was, "Supplied the other word; generally see the two together."

Another factor that probably plays an important part in determining whether or not the influence of the *and* form is to be successful is the sort of ideational complex or system that is called up by the first of the two stimuli given to the subject. If this system be of such a character that the second of the two stimuli does not readily fit into it there is reason to believe that there will result an inhibition of the association of the first stimulus, with the second stimulus, and hence a case of unsuccessful influence. If the system is such that the second stimulus does fit into it, then the association of the first stimulus with the second stimulus will be aided.

As an example of the first kind, where inhibition results, we have stimulus, Rolls; response "Roly-poly." The individual had a picture of the toy roly-poly. Consequently when Coffee *and*—was given as the second stimulus the subject already had a system in consciousness into which this second stimulus did not fit. His response was not Rolls, but Tea. On the other hand, with the stimulus Beans the reply "Baked" would generally imply a complex into which the second stimulus, Pork *and*—would readily fit. And the results of the three cases in which the stimulus Beans did bring the response "Baked" show that this supposition is probably true, for all three subjects replied "Beans" when Pork *and*— was given as the following stimulus. It must be remembered, however, that there are no doubt cases in which the motor habit formed by continually associating such words as Pork and Beans would bring out the response Beans to the stimulus Pork *and*— even though the first of the two stimuli had aroused an associational system that would tend to inhibit this association from taking place. Such, for instance, is the case of the subject who replied to the stimulus

Beans with "Bean family at home," yet to Pork *and*— replied "Beans."

This is simply a case of motor habit being stronger than the inhibitory character of the association complex aroused by the first stimulus. And the fact that the influence is successful as judged by the reply does not really indicate that there was any influence of the first stimulus word causing the reaction to the second stimulus to be what it is. Nor does it in any sense indicate that the second stimulus became a part of the complex aroused by the first stimulus, but rather that there is merely a motor reply, often without any parallel ideational content. This is evidenced by such expressions in introspection as "Purely automatic," "Just dropped out," "Couldn't get anything else," and others of a similar nature.

The point to be here emphasized is, that there is much reason to suppose that association is something more than a re-arousal of cerebral cells that have already been excited together. It is a process of inhibiting the passage of nervous excitation from and to one or more groups of cells as much as it is the actual passage from and to other such groups of cells. Association is of this double character, transference of excitation, and inhibition of excitation.[8] As this part of the experiment was not designed to test this particular point, its mechanism did not give results that can conclusively settle the question one way or the other. But the results do suggest the probability of such a conclusion.

The possibility of the successful or unsuccessful character of the *and* form of influence affecting the length of the reaction time to the second of the paired stimuli still remains to be considered. A measure of this effect is given by taking the average of all the reaction times accompanying successful influences for a given pair, and comparing this average with the average of all the reaction times accompanying unsuccessful influences for this same pair. By such a method it was found that for 9 of the 10 pairs used the successful influences gave shorter reaction times

[8] Shepard and Fogelsonger: Studies in Association and Inhibition. *Psychological Review,* Vol. XX.

than the unsuccessful influences. The amount of this saving in reaction time averaged 438 sigma for each of the 10 pairs.

Looking at the individual subjects we see that the average time of the successful influences is less than the general average reaction time in 93 per cent of the thirty cases; that the average reaction time of the unsuccessful influences is less than the general average reaction time in 60 per cent of the cases; and that the average of the reaction times of both the successful and unsuccessful influences together is less than the general average reaction time in 90 per cent of the cases. These consistently high percentages lead us to believe that the "and," whether it suggests one word or another, by the very fact that it is there does serve to suggest some word, and that suggestion by limiting the number of possible reactions to one or two responses shortens the reaction time. The presence of the "and" also changes the character of the stimulus from one of completeness to one of incompleteness, and we have already seen that a stimulus incomplete in character gives a shorter reaction time than does one complete in character.

Preceding Verbal Form.

Judging from the Tables, F-1 and F-2, together with their summary Table F_a we must conclude that the preceding verbal form does not influence the interpretation of immediately following ambiguous verbal forms. We see, in fact, in the total of ten such ambiguous forms a greater percentage of interpretations as nouns when the preceding definite form was a verb than when it was a noun. There is but a single case, that of No. 3, that gives any real evidence of influence of preceding verbal form. There are but three of the ten ambiguous forms, Pick, Boil, and Stand, that were not predominantly interpreted as nouns. These three words are probably used much more commonly in their predicative connection than in their substantive relation. It is probably due to this habitual form of use that we have them so interpreted in this experiment. This view is supported by the fact that it so happens that they were interpreted as nouns in a greater percentage of cases when they were

preceded by verb forms (43, 43, and 57 per cent than when they were preceded by noun forms (35, 22, and 39 per cent.) Since this fact holds for all three words it would lead us to seriously question the possibility of the interpretation being influenced by the preceding definite verbal forms. That there is variation, as shown by the tables, in the manner in which various subjects interpret the same form under the same preceding verbal conditions would also lead us to suppose that it must be some individual factor such as habitual use or particular experience that leads to the particular interpretation. Any recent or vivid experience may thus, in the individual case, be the dominating factor in the interpretation. The evidence for this kind of influence is strongest when we have a stimulus, like boil, generally interpreted as a verb (73 per cent), interpreted as a noun with the introspection by the subject that it made him think of a big boil that he had just had on his neck.

Summarizing Table F-1 and F-2 we find that there are 5 reactions that were failures. This leaves 295 reactions to ambiguous forms. Of these 295 reactions, 195 were interpretations of the ambiguous form as a noun. But this fact is even more striking when we state that in over half (110) of these cases the ambiguous form was preceded by the definite verb form.

It is probable that we use substantives in isolation more than we use verbs in isolation, and hence are more apt to interpret these indefinite forms as nouns. If this be true, it goes back again to the theory of interpreting stimuli according to the way in which they are habitually perceived and used.

Preceding Condition

The detailed results of the experiments testing the influence of a given preceding condition upon the reaction to the stimulus word immediately following this statement of condition are given in Table G. Out of the possible 130 reactions obtainable, only 117 were secured. Of this number there was evidence, either in the reaction word itself, or in the introspection, of the influence for which we were testing in 82, or 70 per cent, of the cases. The percentage of successes for each of the five words used is

as follows: Nationality 67 per cent, Tom 75 per cent, Organ 82 per cent, Brush 52 per cent, and Shrill 70 per cent. For each subject there was obtained an average of 3.9 reactions under this kind of condition, while the average of successful influence for each subject was 2.73.

The most interesting part of this test is shown in the reaction times. There were fourteen subjects whose average reaction times to those stimuli over the response to which the previous condition did exert an influence, were longer than their general average reaction times by an average of .334 for each of the fourteen cases. There were also fourteen subjects whose averages for those stimuli under the same conditions were less than their general average reaction times by an average of .491. This, however, makes an average saving for the twenty-eight subjects of only .028.

There were likewise nine subjects whose average reaction times for those stimuli with which the preceding condition did not influence the reaction were longer than their general average reaction times by an average of 1.239 per subject. Of the ten whose average reaction times for those stimuli were shorter than their general average reaction times, it was so by an average of .310, making an average increase for each of these nineteen cases of .424.

The interest in these figures is chiefly in the bearing they have upon the inhibition character of association. From this point of view two facts are of prime importance. First, the decidedly lengthened character of reaction (average of 1.239 for each of the nine cases) with which the unsuccessful influence on response is accompanied. Second, the fact shown by the table, that whenever there is a lessening of the reaction time with the successful influence it is generally (though not always) a decided lessening. These facts would warrant us in saying that when the complex aroused by the condition is not such an one that the following stimulus word will fit into it, then this condition causes a decided inhibition of association reaction; but when this complex is favorable then it causes a decided shortening of the time required for this process. It is true, even in those cases in which

the influence of the condition is successful, that the very newness of the condition under which the subject is reacting may cause a retardation of reaction time. Thus we have explained the fact that there are as many cases in which the successful influence requires a longer reaction time as there are cases in which it requires a shorter one. But we must notice that this reaction time is never above a second longer, while the shortened reaction time is above a second shorter in three different cases.

III. CRIMINAL ASSOCIATION TESTS

Discussion of the Method

The second part of our work consisted in testing experimentally the applicability of the association method as a means of determining the guilt or innocence of an individual suspected of a criminal act. In the series of experiments that were performed for this purpose we made use of the same group of students who had already acted as subjects in our first series of experiments. A double advantage was thus attained. We had subjects who were familiar with the mechanical details of the experimental method employed, and were consequently acting under familiar conditions. We also had at hand from the preceding tests, for each subject to be tested for the presence or absence of guilty knowledge, data showing the average reaction time for each of the verbal forms of reaction (noun stimulus—adjective reaction; noun stimulus—noun reaction; noun stimulus—verb reaction; etc.).

The impracticability of having any of the subjects actually commit a crime made it necessary to devise an act the details of which would approximate, as closely as possible, the details of a real criminal action. Such an act having been formulated by the operator, another person selected several subjects and carefully instructed them in the method of performing the act. The operator then tested all the subjects concerned in the experiment and from the results obtained with each individual subject passed a judgment as to the guilt or innocence of that subject.

No attempt was made to evaluate the data secured in these

criminal association tests according to the "frequency tables" method. The operator, in forming his judgment, made use of the same criteria that were employed by Jung.[1] However, the method here employed was a refinement of the Jung method in one respect. It was decided that a much more accurate indication of guilt or innocence could be obtained if a subject's reaction time to a stimulus of the supposed guilty type were compared with the average reaction time of that subject to words of the same verbal form as the stimulus in question, than if this reaction time were compared with the subject's general average reaction time to stimuli of all the various verbal forms. This decision was justified by the fact that the results obtained in the first series of our experiments not only confirmed, but emphasized the results already obtained by earlier investigators, showing that there is a variation in the length of reaction time dependent upon the verbal form of the stimulus.

It had been hoped that the various tests that had been used in the first series of the experiment for the purpose of determining the possibility of influencing reactions and reaction times would result in a body of data that would make the association test a more delicate diagnostic mechanism. However, such a body of data was not obtained. Preceding definite verbal forms were found to have practically no influence upon the nature of the reaction to following ambiguous verbal forms. The influence of a statement of a given situation upon the reaction to an immediately following stimulus was found to be considerable. Yet this fact is unimportant as an aid in the determination of the presence of guilty knowledge when it is considered in connection with the lack of uniformity in length of reaction time which accompanies these cases. Even with the cases of successful influence of the preceding condition there were as many instances in which the reaction time was greater than, as there were instances in which it was less than, the general average reaction time. Moreover, with the cases in which the influence was unsuccessful there were many instances of markedly lengthened reaction time. Therefore, if one were attempting to test a

[1] See Introduction, page 7.

suspect by such a method and did actually obtain a much longer reaction time in the case of an unsuccessful influence of a stated *guilty* preceding condition it could be considered as evidence of neither guilt nor innocence. It would be impossible to determine whether the lengthened reaction time were the result of an inhibition caused by the arousal of an emotional complex, or the result of an inhibition caused by the arousal of a non-assimilating complex.

A general criticism that may well be made of the so-called criminal tests carried on in other laboratories is this; the man making the test was given three or four subjects to determine which one of this number was guilty. It was an easy matter from a comparative study of the results of these tests to pick out this one. I feel perfectly confident that with an observer of only average astuteness, under such conditions, failure is well nigh impossible. But such conditions as these are seldom found in the world of actual crime. There one is confronted with one or more subjects and the question is no longer "*which* is the guilty man," but rather, "are *any* of these guilty?"

In our tests we attempted to make the conditions as near an approach to reality as possible. To this end each person in the criminal series was tested as an individual and isolated case. A decision as to his guilt or innocence was reached before the next case was passed upon.

Also in carrying out the details of the pseudo criminal action every effort was made to cause the action to have the influence of a real crime upon the individual. With the real criminal, either through the emotional excitement or as the result of his careful and conscious planning, the details of the crime are almost indelibly impressed upon his memory. Almost always, also, the first of these causes works, because excitement, due to some hitch in the carrying out of his plans, some sudden surprise, or fear is present during the period of the commitment of the crime. The criminal, moreover, has a decided motive to keep the knowledge of his guilt to himself. This motive is intense because it means liberty, happiness, or even life itself.

While it was realized that it would be impossible to bring in

all these factors in a merely pseudo crime, in a degree even approximating their normal strength, yet we tried to make each as active a force as possible. To secure impression of detail on the mind of the subject, as definite instructions as possible were given in typewritten letters. Moreover, every detail of the action was worked out with one end in view—that of leaving definite impression. The element of surprise was effectively brought in by making it impossible for the subject to fulfill all the instructions, which failure left him in a rather unpleasant situation. The motive for concealment was present in a slight degree for nearly all the subjects who were put through the act entered heartily into the spirit of the test. They looked upon the whole thing as a sort of game at which they were trying to beat the operator. This spirit of the game was further increased by the offering of a slight reward to any subject who could conceal from the operator the fact that he committed the act.

The details of the pseudo criminal act were planned by the operator. The people[2] who were to act as criminals were selected from the list of subjects by Dr. Shepard of the Psychology Department. By him they were given a letter of instruction similar to the following:

> You have been selected to act as the criminal for group number 1. Please be particular to follow these instructions and those that you receive later on, with as great an amount of exactness as possible. Put yourself in the position of a criminal who is prowling around to get whatever he may find.
>
> Enter the psychology lab. from the North entrance—just as the library clock is striking the hour of 9 on the evening of March 26th (Tuesday). Proceed into the amphitheatre. On the table you will find a letter of furthen instructions. Follow these instructions carefully. Take particular notice of all the details about the table and the room. It is necessary that you be out of the building by 9.45; this, however, will give you plenty of time.
>
> It is necessary to the success of the experiment that you keep as quiet as possible and be careful not to show too much light as you might attract the attention of passers by, or of the campus night-watch.

In the building the keys had been removed from the electric light switches. On a table in the amphitheatre, upon a white

[2] While a number of people went through the act, only one went through at any one time.

towel, were placed two fried cakes, a bottle of Puritan grape juice, a box with two Melachrino cigarettes. There were also on the table a lighted candle in a candlestick, some sulphur matches in a box, three pennies, a Prince Albert tobacco can, a picture of three dancing girls, which was wrapped in a piece of red tissue paper, two books—"Defrauding the Government," and "The Case of Dr. Horace."—, and the following letter of instructions:

March 26, 1912,

Letter of Instructions:

Select from the books on the table the one entitled "The Case of Dr. Horace." Note the name of the author and then turn to pages 116, 117, and 118,* and read them carefully.

Eat anything that you may find to eat. After this, smoke a cigarette, noting the brand. Then carefully investigate the contents of the table, taking anything that may seem of value to you and hiding it somewhere in the amphitheatre. If you do not wish to find yourself in an extremely embarrassing situation you will find it advisable to be out of the building at 9.45.** But at any rate take plenty of time to follow these directions carefully and thoroughly.

If you do follow these directions carefully, and can prevent the examiner from finding out that you are the guilty party, you will receive as a reward a box of candy (Martha Washington Candy) or, at your option, fifty cents worth of OWL cigars, or two boxes of Philip Morris cigarettes.

*The book "The Case of Dr. Horace," was a detective story, and the particular pages here given to be read were selected because of their local coloring. They described events taking place between Ann Arbor and Jackson. It was thought that this would impress the name of the book upon the subject.

**Once the subject was inside the amphitheatre the outside door was carefully and quietly fastened from the outside; the windows had already been nailed from the outside. Thus the subject was taken by surprise when he attempted to leave the building. Practically all the subjects forced the windows.

Of the subjects tested there were several of the innocent ones who unwittingly gave away this fact by their attitude or remarks. These cases, and some others were considered worthless. I have selected for presentation here three cases that are typical of quite different sorts of results. After each case given, the conclusions of the operator, together with the basis for the same, and the actual facts as to the guilt or innocence of the subject tested will be given. The words that were inserted because of

their connection with the details of the act are marked with the asterisk. The numbers in parentheses are the subject's average reaction times for that particular form of reaction, noun—noun, noun—adjective, etcetera. Words or reaction times marked @ are those which the operator considered as giving evidence of guilt. The last column of figures gives the reaction times for the repeated series.

CORRECT JUDGMENT OF GUILTY

Case No. 24

1. Coat	———		———		———
2. Bitten	Sweet		1.136		1.286
3. Cream	Butter		1.280		.906
4. Peaches &	Cream		———		.869
5. Wall	Paper		.870		.743
6. Smoke*	Tobacco	(1.038)	1.334 @	Good @	.865
7. Philip*	Holmes		1.072	I @	.777
8. Winsome	Smile		.968		.940
9. Dish	Water		.780		.812
10. Foot	Sore		.954		.933
11. Paper*	Wall	(1.100)	1.464 @	Paper @	.777
12. Tissue*	Paper	(.741)	1.521 @	Good @	1.289 @
13. Pipe	Smoke		1.255		———
14. Albert*	Edward		1.386	Prince @	1.171
15. Prince*	Albert	(.741)	1.269 @	Wales @	1.435
16. Quiet	Room	(.786)	1.444 @	Smoke @	1.112 @
17. Dinner	Party		1.321		1.007
18. Rain	Drop		1.088	Coat	.977
19. Bull	Red		1.815		1.095
20. Ink	Ink		.940	New	.662
21. Book*	Desk	(.912)	1.389 @	High @	.978
22. Case of*	Books		1.113		.786
23. Doctor*	Bush		1.391	Good @	.772
24. Meek	Smile	(.786)	1.059 @	Old @	.522
25. Poet	Laureate		1.076		.873
26. Block	Wood		1.076	White	.795
27. Sing	Song		.932		.832
28. Ginger	Bread		.881		.790
29. Flower	Bed		.885		.812
30. Bottle*	Ink		.963		1.061
31. Grape*	Red	(1.100)	1.212		.634
32. Juice*	Blue @	(1.100)	1.152	Good @	.571
33. Oval	Window		.922		1.246 @
34. Knee	Sprung		1.209		.794
35. Vase	Church		.772		.877
36. Leather	White		.662		.784

37.	Clock*	High @		.685	New @	.794
38.	Library *	Clock	(.741)	.925	Book @	1.383 @
39.	Human	Mind		.990	Man	.765
40.	Tin*	Box @	(.786)	1.360 @		.729
41.	Cents*	Blue @	(1.100)	.881 @	Man @	.736
42.	Three*	Good @		.664	Bed @	.879
43.	Life	High		.778	Bright	.986
44.	Pencil	Short		.613	Blue	.561
45.	Frog	Bright		.634	Leg	———
46.	Swamp	———		———		———
47.	Queen	White		.928	Elizabeth	.826
48.	Apply	Apple		1.054		.755
49.	Search	Me		1.257	Quick	.733
50.	Expert	———		———		———
51.	Reward*	Me	(.880)	1.222 @	Buy @	.563
52.	Candy*	Cheap	(1.100)	1.078	Red	.842
53.	Box of*	Candy	(.795)	1.223 @		1.284
54.	Washington*	George		1.457		.468
55.	Martha*	Kusterer		1.273	Hyde	.371
56.	Sly	Fox	(. 786)	1.257 @		.826
57.	Cigars*	Cheap		1.057		.888
58.	Owl*	Cigars @	(.741)	1.722 @	Wise @	.601
59.	Ancient	Old		.910		.789
60.	Unexpected	Quick		1.114		1.037
61.	Stove	Man		.659	Polish	.770
62.	Oil	Good		1.601	Cheap	.926
63.	Extreme	Boy		.610	Good	1.036
64.	Modern	Boy		1.060	New	1.193
65.	Door*	Knob		.994		.566
66.	Locked*	Pain		.826	Door @	1.962 @
67.	Escape*	Quick	(.983)	1.127	Pain	.819
68.	Window*	Sash	(.912)	1.216 @		1.143
69.	Climb*	Back	(.983)	1.418 @	Good @	———
70.	Pure	Food		.972		.795
71.	Blind	Bat		1.285	Mice	.815
72.	Book*	Blue		.732	New	.971
73.	Hide*	Seek		1.047	High	.870
74.	Bone	Ash		1.134		———
75.	Sharp	Eyes		———		.712
76.	Stick*	Pin		.919		.607
77.	Candle*	High		.732	Good	———
78.	Grind	Quick		.932	Man	———
79.	Play	Good		1.616	White	.904

A judgment of guilty was correctly made in this case. The grounds for this judgment may readily be seen by referring to the words and times marked @ in the preceding list. The main grounds may be summarized as follows:

1. Lengthened reaction times in the case of the guiltily associated stimuli numbers 6, 11, 12, 14, 21, 40, 51, 53, 58, 68 and 69; and in the reaction times to stimuli numbers 16, 24, and 56 which immediately followed words with guilty associations.

2. The shortened reaction time for stimulus No. 41, taken in connection with the nonsense reaction "blue."

3. The lengthened reaction time for stimuli numbers 15, 38, 53, and 65, and 34 (immediately following a changed response to a guilty test word) in the repetition series.

4. The fact that 73 per cent of the responses to the words of supposedly guilty association tendencies were changed in the repetition series, while only 39 per cent of the responses to all the other stimuli were changed.

5. Nonsense character of reaction words to stimuli 41 and 42 in both the original and the repetition series.

6. The peculiarly suggestive character of the reaction word in a number of cases. (1) In the second series, immediately after the stimuli Prince and Albert, the response Smoke was given to the stimulus Quiet. This indicated that the Prince Albert tobacco combination had been called up, even though the response to Prince had been Wales. This is particularly suggestive owing to the fact that the reaction time for Prince—Wales was greater than the reaction time for Prince—Albert in the first series. (2) The response "Blue" to the stimulus Juice (as the grape juice was blue). Response changed to "Good" in the repetition series. (3) The response "High" to the stimulus Clock (the library clock is high). Response changed to "New" in the repetition series. (4) The response "Box" to the stimulus Tin, especially with the accompanying marked retardation in the reaction time.

The two bits of evidence that were most convincing were the reaction "Owl" for the stimulus Cigars with the accompanying great increase of reaction time and the change of the response to "Wise" in the repetition series, and the response "Door" to the stimulus Locked in the repetition series, together with the great lengthening of the reaction time.

The introspections of this subject were as follows: "The

method used to conceal guilt was to think out before the test words to associate with words that I thought would be most likely used to detect me. In addition to this I tried to have in mind some noun or adjective that would go with most anything, and use this if the word exposed were incriminating. All that I knew about the test was that it was something like the first association test.

"The words which had a guilty association at first were as follows: Philip, Doctor, Grape, Juice, Cents, Three, Candy, Washington, Martha, Door, Locked, Window, Candle. The ones which called up a guilty association after the response were: Smoke, Case of, Library, Owl, Climb, Book, and Escape.

"I was conscious a few times of delay when a word of the 'guilty' type appeared before giving the word. The feeling of guilt acted as an inhibition to making any association, and if the word given in reply were incriminating I would be painfully conscious of the fact. In the second test I was able to remember where I had made some guilty associations and use new words. These new words were prepared before hand and kept in readiness. In some places I was able to shorten time reactions which would indicate guilt where the words given did not. With some words of the 'guilty' type I got associated words which I had not prepared beforehand and which were not associated with the 'crime,' as, for example, Doctor, Stick, Case of, Pencil and Book.

Incorrect Judgment of Guilty

The conditions in this test case were practically the same as in the other. A newspaper was added to the items on the table; a box of Zuzu ginger snaps was also added; a comic picture of several musicians gazing after a passing girl and entitled "A Rubber Band" was inserted in the book at the pages which the subject was instructed to read.

Case No. 30.

1. Coat	None	2.381		.798
2. Bitter	Sweet	1.229		1.348
3. Cream	Ice	1.351	Sweater	.189

4.	Peaches &	Cream		1.270		.604
5.	Wall	Street		.760		.568
6.	Smoke*	Fire	(1.156)	1.192		1.059
7.	Philip*	Man		2.240 @	Wild	.639
8.	Winsome	Lady		1.145		.646
9.	Dish	Pan		.846		.583
10.	Foot	Pad		.883		621
11.	News*	Paper		.881		.703
12.	Paper*	Basket		1.095		771
13.	Tissue*	Paper	(.821)	1.204 @		.513
14.	Pipe	Smoke		1.866	Wrench	.249
15.	Albert*	Marks		1.640	Prince	.893
16.	Prince*	Albert	(.821)	1.545 @		.767
17.	Quiet	Room		1.115		.788
18.	Dinner	Pail		1.514		.506
19.	Rain	Storm		1.384		.669
20.	Bull	Durham		1.354		.568
21.	Ink	Paper		1.714	Stand	.556
22.	Book*	Wrack	(.925)	1.442 @	Mark	.564
23.	Case of*	Slander		1.248		1.245
24.	Doctor*	Jones		1.100	Bolz	.890
25.	Meek	Person	(1.000)	1.915*	Lady	.553
26.	Poet	Laureate		.897		.767
27.	Sing	Song		.905		507
28.	Snap*	Shot		.618		.535
29.	Ginger*	Ale		.645		.452
30.	Flower	Pot	(1.000)	1.403 @		.648
31.	Bottle*	Wine		.853		.654
32.	Grape*	Juice		1.156		.346
33.	Juice*	Grape	(1.101)	1.401 @		525
34.	Oval	Window		.857		.639
35.	Knee	Trousers		1.712		.830
36.	Vase	Circular		2.443	Flowers	771
37.	Clock*	Work	(.925)	1.107		.504
38.	Library*	Table @	(.925)	3.054 @		.767
39.	Human	Voice	(1.000)	1.324 @	Being	.564
40.	Tin*	Pan	(.925)	1.412 @		.458
41.	Cents*	Dollars	(1.156)	2.100 @		.733
42.	Three*	Men	(1.000)	1.340 @	Cents @	1.937 @
43.	Life	Saver	(.925)	1.842 @	———	———
44.	Pencil	Ruler	(1.156)	3.006 @	Sharpener	.720
45.	Frog	Horn	(.925)	1.612 @		1.226
46.	Swamp	Ground	(1.156)	3.500 @		.816
47.	Band*	Iron	(1.028)	2.133 @	Stand	.606
48.	Rubber*	Stamp		.934		.596
49.	Queen	Wood	(1.156)	2.378 @		1.159
50.	Expert	Cracksman		.981		.751
51.	Reward*	Offered		1.189		.586

52.	Candy*	Kid	(.925)	1.222		.665
53.	Box of*	Tools	(.982)	2.431 @	Candy	.446
54.	Washington*	George		1.882 @	Birthday	1.229
55.	Martha*	Washington	(. 821)	1.771 @		.408
56.	Sly	Man		.792		.580
57.	Cigars*	Stubs		1.050	Brand	.957
58.	Owl*	Brand @		1.070		.341
59.	Ancient	Mariner		1.265		.578
60.	Unexpected	Visitor		.835		.555
61.	Stove	Pipe		1.527		.570
62.	Oil	Machine		1.588	Stove	.601
63.	Extreme	Case		.872		.633
64	Modern	Improvements		1.582		.471
65.	Locked*	In @	(1.020)	.647 @		.506
66.	Door*	Lock @		.977	Key	.732
67.	Escape*	Uninjured		1.330		1.031
68.	Window*	Lock @	(1.743)	1.692		.497
69.	Climb*	Out @	(1.653)	.717 @		.571
70.	Pure	Butter	(1.000)	1.420 @		1.229
71.	Blind	Man		.700		.618
72	Book*	Mark		.739		.506
73.	Hide*	Quick	(1.743)	1.410	Seek	.577
74.	Bone	Head		.865		.632
75.	Sharp	Shooter		.809	Wit	1.183
76.	Stick*	Fast	(1.743)	1.790	Pin	.973
77.	Candle*	Fire	(1.156)	2.167 @	Stick	.788
78.	Grind	Stone		.790	Organ	.624

In this case the examiner felt from the evidence at hand that there was no doubt that he had discovered a guilty subject. This judgment was based on the following facts:

1. Lengthened reaction times in the case of the supposedly guiltily associated stimuli, numbers 13, 16, 22, 33, 38(especially), 40, 41, 42, 47, 53, 54, 55, and 78; for lengthened reaction times in the case of words following the guilty stimuli in numbers 25, 30, 39, 49, and the series 43, 44, 45, 46. The consistent and very decided retardation in these last four cases, which immediately followed the group of three guilty stimuli 40, 41, and 42 gives the strongest kind of evidence of the inhibition resulting from the association trains aroused by the guilty stimuli.

2. Marked lengthening of reaction time to stimulus 42 in the repetition series. (The fact that there was in the repetition series a 34 per cent change in the responses to the guilty stimuli

as opposed to a 24 per cent change in the responses to the non-guilty stimuli was not considered as a strong enough difference to be evidence of guilt.)

3. Suggestions in the nature of the responses themselves: (1) Pair 38-39. For this subject on the preliminary test this indirect form of influence worked in 60 per cent of the cases. The fact that in this case it did not work, together with the fact of the extreme retardation give strong indication of guilty inhibition. (2) Response "Brand" to the stimulus Owl, with a fairly short reaction time. (3) The response "In" to the stimulus Locked, and of "Out" to the stimulus Climb, especially when considered in connection with the very marked decrease in the reaction time, and this being followed—in the latter case—by a retardation in the reaction to the immediately following innocent stimulus seem to clearly indicate the inadvertent guilty reaction. (4) The response of "Lock" to both the stimulus Door and the stimulus Window.

The evidence in this case is certainly as conclusive as in the preceding case, and yet the person tested was not guilty and knew absolutely nothing about the details of the act.

Incorrect Judgment of Innocent

Case No. 29.

1.	Coat	Hat		1.899		.542
2.	Bitter	Sweet		.791		.585
3	Cream	Ice		.946	Cheese	.661
4.	Peaches &	Cream		.750		.882
5.	Wall	Street		.732		.585
6.	Smoke*	It	(1.153)	1.072		.841
7.	Philip*	Smoke @		1.136	Read @	1.143
8.	Winsome	Lass	(1.122)	.899		.746
9.	Dish	It		.740		.586
10.	Foot	It		.597		.658
11.	News*	Item	(1.025)	1.168		.671
12.	Paper*	News	(1.216)	.857		.971
13.	Tissue*	Paper	(.821)	.735		.571
14.	Pipe	It		.893		.609
15.	Albert*	Come		1.556	Prentiss	.999
16.	Prince*	Piper	(1.184)	1.138	Albert	1.160
17.	Quiet	Hour	(1.122)	1.110		.626
18.	Dinner	Time		1.086		.735

19. Rain	Shower		.865		.771
20. Bull	Run		.850		.658
21. Ink	Well		1.055		.571
22. Book*	Time	(1.184)	1.290	Look	.674
23. Case of*	Me		.795	It	.950
24. Doctor*	Hyde		1.080	He	1.821 @
25. Meek	Me	(1.286)	.787		.589
26. Poet	Keats		.808		.749
27. Sing	Song		1.195		.844
28. Snap*	Shot		.749		.726
29. Ginger*	Ale	(1.025)	.836		.683
30. Flower	Pot		.762		.558
31. Bottle*	Of ale		.867	Of wine	.970
32. Grape*	Juice	(1.025)	.867		.599
33. Juice*	It	(2.469)	.845		.773
34. Oval	Glass	(1.122)	1.094		.782
35. Knee	Cap		.847		.707
36. Vase	Of flowers		.574		.610
37. Clock*	Time	(1.184)	.659		.811
38. Library*	Clock	(.821)	.519		.599
39. Human	Face	(1.122)	.524		.529
40. Tin*	Kid	(1.025)	.587	Face	.533
41. Cents*	Two	(1.390)	.974		.797
42. Three*	Cents	(1.122)	.591		.710
43. Life	Mother	(1.184)	.560	Clock	1.425 @
44. Pencil	Mother		.615	Case	.747
45. Frog	Jump		.845		.645
46. Swamp	Root		.819		.596
47. Band*	Top	(1.025)	1.217 @	Clock	.770
48. Rubber*	Face	(1.025)	1.197	Neck	.698
49. Queen	Sheba		.716		.644
50. Expert	Dentist		.630		.994
51. Reward*	Merit	(1.406)	.738		.635
52. Candy*	Top	(1.025)	.883	Fay	.862
53. Box of*	Fay		.492	Candy	.564
54. Washington*	Irving		.374		.663
55. Martha*	Washington	(.821)	.638		.354
56. Sly	Watch		.528	Peek	.854
57. Cigars*	Box	(1.025)	.944		.865
58. Owl*	Face	(1.025)	.758	Look	.767
59. Ancient	Mariner	(1.112)	.665		.567
60. Unexpected	Escape		.897		.591
61. Stove	Pipe		.925		.627
62. Oil	Stove		.729		.642
63. Extreme	Difficulty		.961		.884
64. Modern	Fiction		———		.637
65. Locked*	Door @	(1.122)	.867		.520
66. Door*	Man		.778	Locked	.580

67. Escape*	Through the Door @		.958	Hard @	.981
68. Window*	Pain	(1.025)	1.030		.587
69. Climb*	High	(1.118)	.848	Hard	981
70. Pure	Water	(1.122)	.609		.532
71. Blind	Man		.683		.743
72. Book*	Door @	(1.184)	.659	Look	.766
73. Hide*	It	(1.153)	.705	Seek	.951
74. Bone	It		.790		.719
75. Sharp	Look		.780		.797
76. Stick*	To it	(1.440)	.651		.664
77. Candle*	Home	(1.184)	.846	Light	.650
78. Grind	Hard		.843		.589
79. Play	Quick		.513	Hard	——

In these results there were only slight indications pointing to any guilty knowledge on the part of the subject tested. These indications were:

1. The response "Smoke" to the stimulus Philip, with the change in response in the second series, together with a slightly long time with both reactions.

2. The response "Door" to the stimulus Locked; of "Through the door" to the stimulus Escape, together with—in the latter case—the change to the response "Hard" in the second series.

3. In the second series the lengthened reaction time to No. 43, which immediately follows a guilty stimulus.

4. The fact that 50 per cent of the responses to the guilty words were changed in the repetition series, while only 12 per cent of the responses to the non-guilty stimuli were so changed.

But all these indications were very slight. Other facts that seemed very much more strongly to indicate the innocence of the subject were:

1. Of the thirty guilty association words the reactions to which corresponded to reactions in the first association experiment upon this subject, the reaction times were shorter in 25 cases, than the normative averages established in that series. The remaining five reaction times were but very slightly longer—never more than .2 of a second. The reaction times in those cases where no comparison was possible were all of moderate length.

2. In no case was the reaction time for a stimulus immediately following a guilty stimulus longer than the normal, with the exception of No .43 of the repetition series.

3. The few cases of apparently meaningless pronoun reaction as Case of—Me, and Doctor—He, could hardly be considered as evidence of guilt, for such reactions were quite common in the earlier test series of this subject.

On the basis of these facts the balance of evidence seemed to be clearly in favor of the innocence of the subject, and accordingly such a judgment was passed by the examiner. Yet this judgment was wrong. The following introspections show how fully this subject had entered into the spirit of the action and the succeeding test:

"I had a method which I thought I could carry through, but was unable to on account of physical and mental conditions with which the crime had nothing to do. I did not try to think of new or innocent associations for the 'guilty' words, but wanted to depend upon a different attitude. In the previous test a certain experience constantly appeared, together with a homesick feeling, which gave the associations. I intended to revive this experience and this feeling, that is, maintain a certain mental attitude unconnected with the crime. I am able to choose my mental attitude to a very great extent, and can place myself vividly in any known place with ease. Had my brain been in its usual state (or normal rather) I could have succeeded to a greater extent, I'm sure.

"I've read everything on this test that came within my reach and always longed to try it. Had *great faith* in its infallibility.

The guilty words were Philip, paper, Albert, Prince, book, case of, doctor, bottle, grape, juice, clock, two cents, candy, Martha, unexpected, extreme, modern, window, bone, and candle. The second time there was little guilty feeling. I had the sensation of having confessed. I knew that it was all up with me long before that, and so the responses were more or less automatic memory responses. In cases where I tried to conceal the first time, I gave the original response (with no guilty feeling, however).

"I had a feeling of being accused—of being guilty—of the accuser's sure knowledge of my guilt, and a great fear. My partner knew of my guilt and that bothered me, too. I had

been sleeping very poorly for some time before being asked to act as a criminal. I thought that the crime made little impression on me. I enjoyed it all very much. Was not a bit frightened, not even when I found the door locked. During the day of my test, however, I had several great nervous strains, and had no chance to take the rest I had planned in order to calm my thoughts. Had a headache, was extremely weary, nervously and mentally fatigued.

"I kept thinking as I saw that I was giving myself away—'Won't get the candy.' After the response 'Escape through the door' came, I didn't try any more to disguise—knew I wasn't acting at ease, which made me feel all the worse.

The above introspection was written by the subject immediately after the test was made. Some days afterward when she was told that she had been judged innocent she gave the following additional introspection:

"I am so surprised at the outcome of the test that I wish to add to what has already been said.

"When I went to commit the crime I felt very criminal. I wore a black scarf over my head, that could easily be drawn over my face. I went by dark and unfrequented streets trying to avoid being seen. I had to pass a lighted store and saw some men coming on the other side. I tried to avoid meeting them and turned my head as I passed them. It was not put on, I just felt like a sneak. When I started I thought it might be well to wear rubbers so that I could go more quietly, but finding the silent tread more noticeable than the common step, I took them off. I carried them for a ways, then thought that they would be in my way. I tried to find a place to hide them, and finally carried them back a block and hid them behind an oak tree.

"As I entered the building I felt bold, determined, and wicked,—ready to do anything. The sight of the bottle and cigarettes pleased me and I thought of 'dime novels.' I had always wanted to see what smoking felt like, but had never had such a good excuse—besides, if I really smoked it, that would add to my sense of guilt. The flickering candle lent a

most 'robber's den' atmosphere to the scene. I was so anxious to try to smoke that I ate only one or two Zuzus before lighting the cigarette. (I had noiseless matches in my pocket.) I proceeded to smoke and to read the books and paper between puffs, enjoying both very much. Then I tried to open the bottle and was sorry I couldn't.

"When about to leave the room I filled my pockets with Zuzus, thinking 'I'm going to get all there is in it, anyway!'—(I like Zuzus) I was glad that I did when I found the door locked, for I had something to eat.

"From this it can be seen that the crime had every chance to make a strong impression upon me, as a crime. Indeed, I felt very guilty, I felt as though I had done something very wrong and this feeling did not pass away until the following Monday noon. (The crime was committed upon Thursday night.) The smoking had been a real crime and the guilt was real, it felt like the real thing!"

As was stated in the introduction, in the undertaking of this series of experiments I had a strong tendency to believe in the efficacy of the association test for the purpose of determining the presence or absence of knowledge of a crime on the part of the subject tested. In attempting to work out a more dependable system by which the results of the tests could be judged, the part of the work that was originally intended to be merely subsidiary came to occupy the position of chief importance, and I feel now, in closing this discussion, that if any contribution has been made to the psychology of association, it has been in the throwing of further light upon the general nature of the association process and the causes of the variation in the length of association reaction times, rather than in any contribution looking toward a practical use of the method.

As to the possibility of such a practical use our results have been entirely negative. These results show clearly that it is possible to make a much finer measurement of the lengthening of reaction times, than has hitherto been made. But they show further, that even with this added refinement, the method can-

not be depended upon as a means of determining guilty knowledge. With certain naïve types, as in the first case given above, it might work. However, the fact that the results pointed so conclusively in one case to the guilt of an absolutely innocent test person, while in the case of the one person who entered most thoroughly into the spirit of the test no positive evidence was obtained, makes it impossible, on the basis of our present knowledge to depend upon this test.

TABLE A. 1-32*

#1.	N.		V.		M.	
Nouns	18	1.396	13	1.342	39	1.151
Pron.			3	.799		
Prop.	3	1.006				
Adj.	4	1.012	5	1.463	7	1.035
Part. A.			13	.757		
Verbs			8	1.287		
Exclam.	1	1.417				
Phrase	1	.941	3	1.040	1	.965
Unclas.			3	1.433	2	.585
Total	27	1,280	48	1.140	49	1.108
Unusable	3		3		1	
N.as Adj.	11	1.006				
Abst. N.	10	1.518				
Gen. Av.	124	1.157				

#2.	N.		V.		M.	
Nouns	22	2.688	10	2.353	19	1.948
Prop.			1	3.248		
Adj.	9	1.749	3	3.019	31	1.629
Verbs	1	2.309	35	1.784		
Prep.			1	2.165		
Total	32	2.412	50	1.929	50	1.750
Unusable	2					
N.as Adj.	6	1.751				
Abst. N.	10	2.490				
Gen. Av.	138	1.969				

#3.	N.		V.		M.	
Nouns	21	1.513	7	1.698	29	1.403
Pron.			33	1.280	7	1.248
Prop.						
Adj.	6	1.050	4	2.064	11	1.316
Verbs			1	2.557	1	1.197
Inter.			1	5.086		
Exclam.	2	1.264				
Phrase			2	1.898	2	1.299
No React.			2	3.448		
Total	29	1.396	49	1.594	50	1.354
Unusable			1			
N. as Adj.	11	1.324				
Abst. N.	10	1.587				
Gen. Av.	126	1.479				

#4.	N.		V.		M.	
Nouns	11	1.305	17	1.243	36	1.059
Pron.			8	.812	1	.635
Prop.	2	1.442			1	.758
Adj.	7	1.145	8	.985	5	.991
Verbs	3	1.239	1	.905		
Inter.	2	1.021	15	1.306	7	1.102
Prep.			1	.708		
Unclas.	2	.973				
Total	27	1.219	50	1.134	50	1.043
Unusable						
N.as Adj.	13	1.129				
Abst. N.	10	3.281				
Gen. Av.	127	1.117				

*5 and *18 omitted, because incomplete.

#6.	N.		V.		M.	
Nouns	17	1.011	32	.909	48	.606
Pron						
Prop.						
Adj.	7	.868	3	1.002	1	.568
Part.A.			15	.887		
Verbs			2	1.097		
Total	24	.969	50	.916	49	.800
Unusable	4				1	
N.as Adj.	12	.864				
Abst.N.	10	1.262				
Gen. Av.	125	.881				

#7	N.		V.		M.	
Nouns	15	1.662	13	2.006	37	1.035
Pron.			18	1.344	1	2.169
Prop.	2	1.667	1	.958	1	.732
Adj.	5	1.311	6	1.253	7	1.101
Verbs	1	.924	4	1.475	2	1.071
Inter			3	2.162	2	3.411
Exclam.	2	1.077				
Prep.			1	1.027		
Unclas.	2	1.114				
Total	27	2.189	46	1.569	50	1.157
Unusable	1		4			
N.as Adj.	12	.979				
Abst. N.	10	1.730				
Gen. Av.	135	1.497				

#8	N.		V.		M.	
Nouns	15	1.203	11	1.471	44	1.326
Pron.	1	.919	26	.985	1	1.561
Prop.	2	1.106				
Adj.	7	1.206	6	1.032	3	1.165
Verbs	2	1.116	1	1.497		
Prep.	2	1.146	5	1.161	2	1.240
Total	29	1.178	49	1.152	50	1.318
Unusable			1			
N.as Adj.	11	.965				
Abst. N.	10	1.180				
Gen. Av.	139	1.194				

#9	N.		V.		M.	
Nouns	9	2.110	15	2.707	27	2.328
Pron.			3	2.499		
Prop.	5	2.013	3	2.027	2	3.334
Adj.	8	1.949	3	2.525	16	2.374
Verbs			3	2.689		
Phrase	5	1.575	12	2.195	1	7.200
Unclas.	1	1.802	5	2.837	1	2.015
No React.	5	1.879	3	2.420		
Total	33	1.930	47	2.502	47	2.483
Unusable	1		3		3	
N.as Adj.	6	1.993				
Abst. N.	10	3.070				
Gen. Av.	127	2.347				

#10.	N.		V.		M.	
Nouns	13	1.837	28	2.583	45	2.097
Pron.			7	2.037		
Prop.	10	1.988	6	1.815	2	1.654
Adj.	13	1.646	4	1.239	1	4.772
Verbs	1	.527	1	2.957		
Unclas.			1	2.958		
Total	37	1.775	47	2.305	48	2.134
Unusable			3		2	
N.as Adj.	3	1.958				
Abst. N.	10	2.673				
Gen. Av.	132	2.094				

#11.	N.		V.		M.	
Nouns	18	1.920	35	2.755	40	2.274
Pron.			4	1.464	1	1.909
Prop.	2	2.216				
Adj.	6	1.998	2	1.241	4	1.561
Verbs	2	1.742	2	3.260		
Prep.			1	1.193		
Unclas.	1	2.485			1	1.946
No React.	2	4.866	4	7.460	1	17.033
Total	31	2,151	48	2.951	47	2.515
Unusable	1		2		3	
N.as Adj.	8	1.566				
Abst. N.	10	4.601				
Gen. Av.	126	2.591				

#12.	N.		V.		M.	
Nouns	20	1.651	31	1.697	34	1.359
Pron.			3	1.861		
Prop.			3	.878		
Adj.	3	1.266			4	1.201
Verbs			8	1.355	1	1.998
Exclam.	2	1.297				
Phrase	5	1.255	12	1.434	10	1.561
No React.	1	1.705	1	3.043		
Total	31	1.539	46	1.572	49	1.398
Unusable	1		4		1	
N. as Adj.	8	1.266				
Abst. N.	10	2.065				
Gen. Av.	126	1.494				

#13.	N.		V.		M.	
Nouns	12	1.470	33	1.466	42	1.077
Pron.			7	.956		
Prop.	3	1.713	2	3.486		
Adj.	7	1.157	9	1.132	2	.734
Verbs	3	1.115				
Phrase	2	1.019	6	3.276	1	.884
Unclas.	3	2.386				
Total	30	1.447	47	1.471	45	1.057
Unusable	1		3		5	
N.as Adj.	9	.985				
Abstr. N.	10	1.722				
Gen. Av.	127	1.361				

#14.	N.		V.		M.	
Nouns	10	3.004	25	3.629	36	2.446
Pron.			9	3.306		
Prop.			2	1.678		
Adj.	7	3.498	2	3.454	3	2.020
Verbs	5	2.102	2	3.194	1	3.584
Unclas.	3	1.410	9	3.156	7	4.494
Total	25	2.554	49	3.360	47	2.961
Unusable	1		1		3	
N.as Adj.	16	1.836				
Abst.N.	10	3.741				
Gen. Av.	119	3.047				

#15.	N.		V.		M.	
Nouns	28	1.555	31	1.906	32	1.598
Pron.			8	1.643		
Adj.	4	.955	6	1.329	9	1.870
Verbs	1	1.274	1	1.951	2	3.277
Prep.			2	2.092		
Total	33	1.474	48	1.799	49	1.737
Unusable			2		1	
N.as Adj.	7	1.589				
Abst. N.	10	2.485				
Gen. Av.	130	1.654				

#16.	N.		V.		M.	
Nouns	22	1.229	25	1.244	40	1.039
Pron.			16	1.023	5	1.099
Prop.	1	1.816				
Adj.	5	1.262	6	.766	2	1.560
Verbs	3	1.054			2	1.018
Phrase	1	.913				
Total	32	1.197	47	1.108	49	1.089
Unusable	2		3		1	
N.as Adj.	6	.987				
Abst. N.	10	1.079				
Gen. Ave.	134	1.124				

#17.	N.		V.		M.	
Nouns	23	2.642	23	2.485	21	2.054
Pron.			3	2.170		
Prop.	2	1.388	2	7.713	6	3.670
Adj.	4	1.771	3	1.872	21	2.096
Verbs			15	2.067		
Phrase	1	3.015	3	2.876		
Unclas.			1	1.603		
Total	30	2.448	50	2.507	48	2.274
Unusable					2	
N.as Adj.	10	1.299				
Abst. N.	9	3.158				
Gen. Av.	128	2.406				

#19.	N.		V.		M.	
Nouns	19	1.002	39	1.230	50	1.005
Pron.						
Prop.	1	.848				
Adj.	1	1.035	4	1.108		
Verbs	3	1.334	1	1.341		
Unclas.			1	1.308		
Total	24	1.039	45	1.224	50	1.005
Unusable	1		5			
N.as Adj.	15	1.008				
Abst. N.	7	1.510				
Gen. Av.	119	1.094				

#20.						
Nouns	36	1.375	7	1.839	9	1.648
Adj.	2	1.046	3	2.000	39	1.410
Verbs	1	1.272	39	1.617	1	1.149
Total	39	1.264	49	1.672	49	1.489
Unusable			1		1	
N.as Adj.	1	.955				
Abst. N.	9	1.963				
Gen. Av.	137	1.490				

#21.	N.		V.		M.	
Nouns	21	1.002	27	1.139	37	.850
Pron.			1	.739	1	1.456
Prop.	1	.950				
Adj.	2	1.259	3	.957	8	.753
Verbs	1	.850	8	.881	2	.923
No React	1	.939	1	1.750		
Partic.			2	1.011		
Unclas.			1	1.500		
Total	26	1.011	43	1.081	48	.850
Unusable	3		7		2	
N.as Adj.	11	.888				
Abst. N.	10	1.362				
Gen. Av.	117	.971				

#22.	N.		V.		M.	
Nouns	11	1.096	20	1.679	46	.981
Pron.			20	1.188	1	2.089
Prop.	4	1.350				
Adj.	8	1.138	6	.938		
Verbs	6	1.100	1	1.787	3	1.587
Total	29	1.140	47	1.378	50	1.089
Unusable			3			
N.as Adj.	11	.932				
Abst. N.	10	1.551				
Gen. av.	136	1.189				

#23.	N.		V.		M.	
Nouns	20	1.326	13	1.127	35	.879
Pron.	1	.921	14	.935		
Adj.	2	.826	17	1.125	11	1.034
Verbs	1	1.662				
Exclam.	3	1.189				
Phrase	3	1.267	5	1.095	4	1.183
No React.			2	1.618		
Total	30	1.270	50	1.109	50	.958
N.as Adj.	10	.944				
Abst. N.	10	1.452				
Gen. Av.	130	1.080				

#24.	N.		V.		M.	
Nouns	12	.912	13	1.038	41	.786
Pron.			23	.880	3	.896
Prop.			1	1.070		
Adj.	8	1.100	13	.983	4	.703
Verbs	1	1.121	1	.803		
Unclas.	1	.777				
Total	22	.983	50	.947	48	.786
Unusable	1				2	
N.as Adj.	17	.840				
Abst. N.	10	1.104				
Gen. Av.	130	.889				

#25.	N.		V.		M.	
Nouns	10	.856	24	.843	39	.749
Pron.			9	.663		
Prop.	1	.517	1	.877		
Adj.	1	.670	9	.803	4	.757
Verbs	12	.744				
Unclas.			1	1.143		
Completions			5	.565	6	.685
No React.			1	.905	1	1.217
Total	24	.777	50	.783	50	.758
N.as Adj.	16	.795				
Abst. N.	10	.896				
Gen. Av.	124	.769				

#26.	N.		V.		M.	
Nouns	24	1.687	19	1.945	52	1.651
Pron.			9	1.561		
Prop.	1	2.746				
Adj.	3	1.290	3	1.475	14	1.561
Verbs	3	1.437	15	2.674		
Unclas.	1	1.348			3	1.883
Repetition	1	2.095	1	5.827		
Total	33	1.618	47	2.157	49	1.640
Unusable	1		3		1	
N.as Adj.	6	1.530				
Abst. N.	10	2.066				
Gen. Ave.	129	1.978				

#27.	N.		V.		M.	
Nouns	20	1.048	7	1.362	17	.989
Pron.			10	.821		
Adj.	4	.997	3	1.251	30	.957
Verbs	6	1.082	28	1.057	1	.980
Phrase			1	1.452		
Total	30	1.048	49	1.073	48	.956
Unusable			1		3	
N. as Adj.	10	.830				
Abst. N.	10	1.092				
Gen. Av.	127	1.035				

#28.	N.		V.		M.	
Nouns	22	.658	12	1.043	17	1.048
Pron.			1	.928		
Adj.	3	.393	1	1.529	31	.809
Verbs	4	.693	23	.631	1	.835
Total	29	.635	37	.797	49	.893
Unusable	5		15		1	
N.as Adj.	6	.578				
Abst. N.	10	1.648				
Gen. Av.	115	.797				

#29.	N.		V.		M.	
Nouns	21	1.184	8	1.406	27	1.122
Pron.	1	2.469	13	1.153	4	1.286
Adj.	7	1.390	6	1.118	15	1.184
Verbs	4	1.533	17	1.474	2	2.141
Phrase			1	1.440		
Unclas.			1	2.473		
Total	33	1.309	46	1.346	48	1.197
Unusable			4		2	
N.as Adj.	7	1.025				
Abst. N.	10	1.851				
Gen. Av.	127	1.280				

#30.	N		V.		M.	
Nouns	10	1.156	26	1.079	45	1.000
Pron.			8	.788		
Prop.	1	1.434				
Adj.	5	1.028	12	1.653	1	1.020
Verbs	1	1.743			1	1.330
Complet'ns	2	1.065	3	1.787		
Total	20	1.172	49	1.213	47	1.008
Unusable	1		1		3	
N. as Adj.	19	.925				
Abst. N.	10	1.345				
Gen. Av.	116	1.123				

#31.	N.		V.		M.	
Nouns	16	.644	9	.755	38	.641
Pron.			17	.655		
Prop.	1	.678				
Adj.	1	.681	7	.655	5	.646
Verbs	1	.452	1	.477		
Prep.			1	.755		
Phrase			2	.643	2	.642
Complet'ns	1	.843	5	.722	2	.650
Total	20	.648	42	.682	47	.642
Unusable	3		8		3	
N. as Adj.	17	.604				
Abst. N.	10	.728				
Gen. Av.	109	.658				

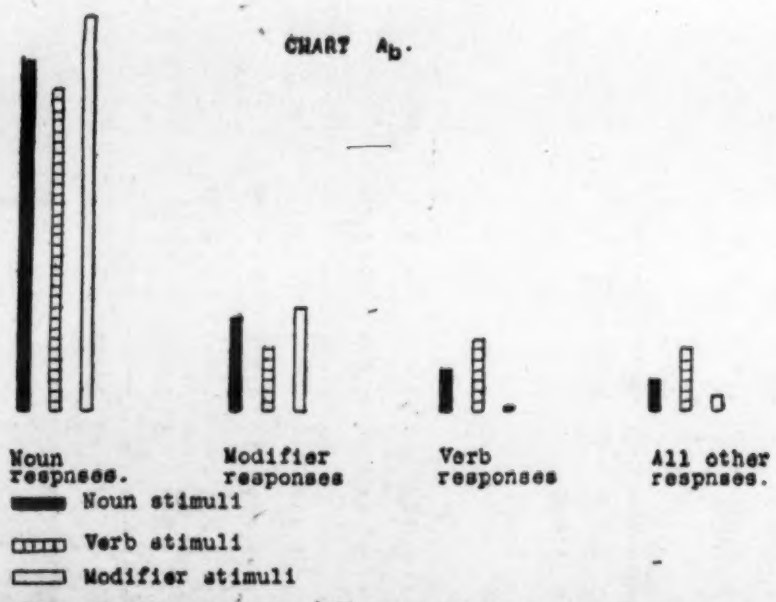
#32.	N.		V.		M.	
Nouns	21	1.295	22	1.609	44	1.467
Pron.			7	1.095		
Prop.	3	1.838	1	2.262	1	1.196
Adj.	6	1.095	7	1.098	3	.834
Verbs	1	.677				
Prep.			7	1.031	1	1.460
Unclas.	1	.938				
Total	33	1.278	44	1.369	49	1.423
Unusable	1		6		1	
N.as Adj.	7	1.153				
Abst. N.	10	1.616				
Gen. Av.	135	1.367				

TABLE A_a.

Summarized results showing the relative length of the average reaction times to Modifier, Noun and Verb stimuli. Number of subjects 30.

	Shortest		Medium		Longest	
	Cases	%	Cases	%	Cases	%
Modifier	20	66.6	7	23.3	3	10
Noun	9	30	13	43.3	8	26.6
Verb	1	3.3	10	33.3	19	63.3

CHART A_b.



This chart represents the proportion of Noun (including Noun, Pronoun and Proper Noun,) Verb, Modifier and All other Responses(including Prepositions, Exclamations, Interrogations, etcetera) responses to each of the three form of stimuli.

The figures represented in the chart are given below. Column #1 gives the total number of responses; #2 the Noun responses; #3 the Modifier responses; #4 the Verb responses; #5 all the other responses.

	1	2	3	4	5
Noun stimuli					
Percent of cases	100	68	18	8	6
Actual number	866	586	155	65	60
Verb stimuli					
Percent of cases	100	62	12	14	12
Actual number	1,399	874	164	197	164
Modifier stimuli					
Percent of cases	100	76	20	1	3
Actual number	1,443	1,090	292	16	45

TABLE A_c.

	Shortest react.time			Medium react. time			Longest react. time		
	N	M	V	N	M	V	N	M	V
Noun Stim.	4	16	10	11	8	7	15	6	7(6)
Mod. "	12	15	3	13	11	4	5	2(2)	5(18)
Verb "	5	16	11	17	10	3	10	3(1)	9(7)
Totals	19	47	24	41	29	14	30	11(3)	21(31)
	21%	52%	27%	46%	32%	16%	33%	13%	23%

This table shows the relative length of reaction times for the three different verbal forms of reaction, both as regards their total appearance for all the stimuli given, and as regards their appearance in connection with each of the three verbal forms of stimuli. The numbers in parentheses signify the number of cases in which the particular form in question did not appear as a reaction. Thus there were 6 out of the 30 subjects who did not use the verb reaction for any of the noun stimuli given.

TABLE B - 1.

	1	2	3	4	5	6	7
1. Use	27	89%	3.280				
2. Imitate	21	67	2.079				
3. Warn	27	74	2.107				
4. Admire	29	80	1.959				
5. Take	29	79	1.940				
6. Find	29	69	1.937	24	2.096	5	1.175
7. Conclude	25	84	1.933				
8. Abuse	25	80	1.870				
9. Suck	29	90	1.797				
10. Kill	29	76	1.775				
11. Threaten	28	75	1.755	23	1.939	5	.955
12. Protect	30	73	1.750	23	1.955	7	1.077
13. Expect	28	68	1.749	23	1.941	5	.867
14. Fail	26	65	1.719	20	1.733	6	1.673
15. Consider	28	54	1.674	23	1.511	5	2.422*
16. Advertise	29	69	1.651	24	1.547	5	2.145*
17. Possess	29	69	1.628	24	1.582	5	1.850*
18. Eat	24	75	1.625	19	1.842	5	.798
19. Read	28	50	1.590	18	1.645	8	1.466
20. Stumble	27	56	1.556	19	1.601	8	1.442
21. Rob	30	50	1.498	25	1.566	5	1.159
22. Despise	29	66	1.496				
23. Provide	30	47	1.492	19	1.736	11	1.071
24. Grow	29	66	1.490	24	1.463	5	1.617*
25. Run	28	66	1.479				
26. Conquer	29	72	1.459				
27. Accept	29	66	1.455				
28. Gather	29	76	1.412	24	1.482	5	1.078
29. Lend	28	32	1.408	8	1.643	6	1.491
30. Sew	30	60	1.372			14	1.237
31. Receive	30	60	1.365				
32. Feel	29	69	1.349	24	1.899	5	1.593*
33. Learn	29	62	1.314	21	1.523	8	1.291
34. Follow	27	48	1.308	13	1.495	14	1.135
35. Send	28	61	1.273	23	1.330	5	1.010
36. Think	29	66	1.269				
37. Get	29	69	1.261	23	1.278	6	1.194
38. Recite	29	59	1.2614	16	1.361-	7	.939
						6	1.639*
39. Allow	30	40	1.231	14	1.646	16	.869
40. Borrow	27	41	1.234	10	1.261	5	1.044
						13	1.368*
41. Believe	30	47	1.213	13	1.538	17	1.117
42. Tell	29	48	1.210	17	1.193	7	1.452*
						5	.925
43. Forgive	30	40	1.210	14	1.466	16	.987
44. Owe	27	48	1.206	14	1.242	7	1.373*
						6	.929
45. Arise	28	64	1.204	22	1.272	6	.957
46. Reap	29	31	1.187	10	1.405	14	1.114
						5	.958
47. Come	29	48	1.140	24	1.183	5	.932
48. Listen	29	59	1.134	22	1.156	7	1.067
49. Bake	29	28	1.091	11	1.363	5	.977
						13	.990
50. Go	30	63	1.066				

TABLES B - 1, B - 2, B - 3. In these tables the various columns appearing after the stimuli give the following facts regarding the reactions and reaction times for these stimuli: Column #1 gives the total number of reactions of all the subjects to each stimulus; #2 gives the percentage of different responses to each stimulus; #3 gives the average of the reaction times of all the subjects to the given stimulus; #4 gives the number of responses of which no one appeared as many as five times; #6 gives the number of same reactions to the given stimulus whenever five or more thanfive subjects have given the same response; #5 gives the average reaction time for the responses represented in column 4, while # 7 gives the average reaction time for the responses represented in column 6; #8 (in Table B - 3) gives the number of times in which the stimulus was interpreted and used as an adjective; # 9 gives the average reaction time for the responses represented in column 8.

The asterisk in column 7 is for the purpose of making it easy to see at a glance which of the average reaction times of those reactions appearing five or more times for a given stimulus are longer than the average of the reaction times of all the other reactions to that stimulus.

TABLE B - 3.

	1	2	3	4	5	6	7
1. Considerate	28	71	3.652	22	3.933	6	1.630
2. Tearful	30	63	1.839	23	3.067	7	1.087
3. Sincere	28	54	1.793	22	1.912	6	1.356
4. Tiresome	29	79	1.778				
5. Harmful	30	80	1.768				
6. Quick	29	79	1.741				
7. Costly	30	73	1.670				
8. Skilful	28	68	1.590				
9. Pleasing	29	83	1.587				
10. Mean	30	50	1.553	16	1.768	14	1.307
11. Alert	26	64	1.541				
12. Unkind	30	63	1.541	21	1.738	9	1.107
13. Marvelous	29	52	1.538	23	1.366	6	2.169*
14. Greasy	30	73	1.531				
15. Careful	27	81	1.440	22	1.409	5	1.573*
16. Sick	30	60	1.429	35	1.919	5	.985
17. Ragged	29	48	1.418	23	1.573	6	.823
18. Peculiar	28	50	1.415	18	1.659	10	.978
19. Boisterous	30	47	1.408	18	1.635	12	1.067
20. Proud	30	67	1.404	24	1.403	6	1.408*
21. Stupid	29	53	1.375	24	1.443	5	1.047
22. Gloomy	30	50	1.362	14	1.799	9	1.123
						5	1.114
23. Nice	26	46	1.332	19	1.329	7	1.303
24. Purple	30	57	1.320	24	1.388	6	1.048
25. Simple	29	55	1.305	15	1.430	9	1.176
						5	1.158
26. Handsome	30	30	1.284	14	1.537	16	1.064
27. Difficult	30	53	1.265	17	1.416	6	.938
						7	1.178
28. Dirty	30	77	1.217				
29. Damp	29	59	1.207	23	1.263	6	.993
30. Dry	30	73	1.201				
31. Bashful	30	40	1.199	15	1.302	15	1.097
32. Weary	30	47	1.196	13	1.548	11	.968
						6	.852
33. Sandy	30	47	1.147	17	1.293	13	.956
34. Yellow	28	64	1.139	20	1.205	8	.975
35. Dark	30	43	1.131	13	1.293	7	1.392*
						5	.666
36. Blue	30	60	1.126	24	1.095	6	1.247*
37. Red	28	79	1.116				
38. Funny	30	63	1.114	23	1.171	7	.938
39. Bright	30	33	1.107	14	1.249	16	.982
40. Muddy	30	30	1.103	8	1.489	7	1.204
						8	.736
						7	.982
41. Dusty	29	52	1.100	18	1.264	11	.830
42. Shady	30	47	1.063	14	1.022	9	1.167*
						7	1.012
43. Slippery	30	40	1.063	11	.943	9	1.389*
						10	.903
44. Ripe	29	34	1.046	13	1.186	5	1.101
						12	.882
45. Windy	30	20	1.040	5	1.317	25	.984
46. Green	30	53	1.015	23	1.067	7	.847
47. Feeble	28	25	1.015	12	.999	16	1.028*
48. Rich	29	28	1.000	6	1.122	15	.856
						8	1.181*
49. Poor	29	38	.996	7	1.209	5	1.146
						6	.835
						5	.845
50. Fresh	29	41	.961	17	1.038	12	.865

TABLE B - 3**

	1	2	3	4	5	6	7	8	9
1. Prison	5	100	3.082					24	1.107
2. Heart	14	93	1.917					14	1.293
3. Farmer	25	63	1.843	18	3.050	5	1.097	7	1.197
4. Goat	29	76	1.817						
5. Ear	24	50	1.679	19	1.752	5	1.400	5	1.408
6. Lawyer	28	79	1.620	22	1.640	6	1.546		
7. Policeman	29	69	1.604	24	1.689	5	1.193		
8. Star	25	56	1.590					4	.878
9. Sky	6	25	1.530					22	.957
10. Baby	12	75	1.516					18	1.096
11. Preacher	29	68	1.496						
12. Needle	27	33	1.496	12	1.765	15	1.278	2	.973
13. Cow	27	48	1.488	17	1.517	13	1.200		
14. Angel	16	81	1.463					14	.987
15. Teeth	29	62	1.453						
16. Onion	25	65	1.443					5	1.031
17. Snake	16	56	1.430					14	.995
18. Apple	7	71	1.413					23	.928
19. Month	28	54	1.375	23	1.387	5	1.320		
20. Mattress	26	31	1.362	12	1.553	14	1.199		
21. Physician	29	48	1.360	15	1.427	9	1.286		
						5	1.294		
22. Stork	28	39	1.344	18	1.509	15	1.201		
23. Chocolate	4	100	1.340					26	.968
24. Hell	29	45	1.334	17	1.492	13	1.111		
25. Negro	25	52	1.313	12	1.633	11	.965	6	.970
26. Hat	27	56	1.276	17	1.440	10	.996	3	1.257
27. Ladder	30	53	1.269	16	1.439	6	1.109		
						8	1.048		
28. Door	14	57	1.254	8	1.292	6	1.304	15	1.005
29. God	28	75	1.247						
30. Lion	30	50	1.187	16	1.376	7	1.018		
						7	.924		
31. Straw	7	43	1.147	3	1.363	5	1.061	32	1.144
32. Cigar	7	71	1.123					23	1.125*
33. Brick	15	53	1.095	10	1.212	5	1.040	13	1.084
34. Cup	26	42	1.092	13	1.170	5	1.109	3	.676
						8	.954		
35. Husband	30	10	.961	3	.969	28	.913		
1. Hesitation	29	86	2.374						
2. Excitement	27	89	2.104						
3. Activity	28	86	2.072						
4. Knowledge	30	50	2.032	24	2.047	6	1.970		
5. Sympathy	30	83	1.928						
6. Decision	30	80	1.858	25	1.931	5	1.496		
7. Wisdom	30	70.	1.652						
8. Purpose	29	86	1.582						
9. Approval	28	86	1.540						
10. Ability	30	67	1.375	20	1.463	5	1.114		
						5	1.286		

** In this tabulation of the noun stimuli the abstract nouns have been put in a separate group at the end. Of the forty concrete nouns, five have been omitted because there was grave doubt as to the proportion of times in which they were used by the subjects as nouns and as adjectives. For further explanation of this table see note on Table B - 1.

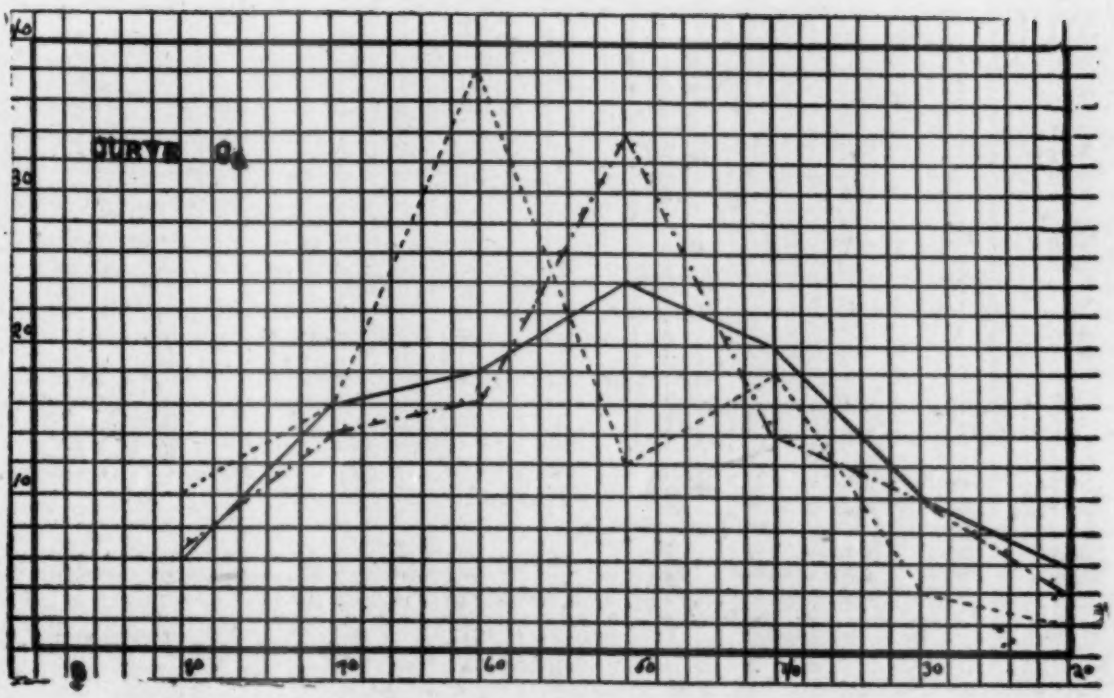
TABLE C.*

VERBS			MODIFIERS			NOUNS		
Gen. Aver. of 50		1.526	Gen. Aver. of 50		1.352	Gen. Aver. of 29		1.426
1. Suck	90%	1.797	1. Pleasing	83%	1.587	1. Heart	93%	1.917
2. Use	89	3.280	2. Careful	81	1.440	2. Angel	81	1.463
3. Conclude	84	1.933	3. Harmful	80	1.768	7% Average		1.690
4. Admire	80	1.952	6% Average		1.598			
5. Abuse	80	1.870						
10% Average		2.168						
1. Take	79	1.940	1. Tiresome	79	1.778	1. Lawyer	79	1.620
2. Kill	76	1.775	2. Quick	79	1.741	2. Goat	76	1.817
3. Gather	76	1.412	3. Red	79	1.116	3. Baby	75	1.516
4. Threaten	75	1.755	4. Dirty	77	1.217	4. God	75	1.247
5. Eat	75	1.625	5. Costly	75	1.670	14% Average		1.550
6. Warn	74	2.017	6. Greasy	73	1.531			
7. Protect	73	1.750	7. Dry	73	1.201			
8. Conquer	72	1.495	8. Considerate	71	2.933			
16% Average		1.718	16% Average		1.648			
1. Find	69	1.937	1. Skilful	68	1.590	1. Policeman	69	1.604
2. Advertize	69	1.651	2. Proud	67	1.404	2. Preacher	68	1.496
3. Possess	69	1.582	3. Alert	64	1.541	3. Onion	65	1.443
4. Feel	69	1.549	4. Yellow	64	1.139	4. Farmer	63	1.845
5. Get	69	1.261	5. Tearful	63	1.839	5. Teeth	62	1.453
6. Expect	68	1.749	6. Unkind	63	1.541	17% Average		1.568
7. Imitate	67	2.079	7. Funny	63	1.114			
8. Despise	66	1.496	8. Sick	60	1.439			
9. Grow	66	1.490	9/ Blue	60	1.126			
10. Run	66	1.479	18% Average		1.414			
11. Accept	66	1.435						
12. Think	66	1.369	1. Damp	59	1.207	1. Door	57	1.254
13. Fail	65	1.719	2. Purple	57	1.320	2. Star	56	1.590
14. Arise	64	1.204	3. Simple	55	1.305	3. Snake	56	1.430
15. Go	63	1.066	4. Sincere	54	1.793	4. Hat	56	1.267
16. Learn	63	1.314	5. Difficult	53	1.265	5. Month	54	1.375
17. Send	61	1.273	6. Green	53	1.015	6. Ladder	53	1.269
18. Sew	60	1.372	7. Marvelous	52	1.532	7. Brick	53	1.095
19. Receive	60	1.365	8. Stupid	52	1.375	8. Negro	52	1.313
38% Average		1.426	9. Dusty	52	1.100	9. Ear	50	1.679
			10. Mean	50	1.553	10. Lion	50	1.187
1. Recite	59	1.361	11. Peculiar	50	1.415	34% Average		1.348
2. Listen	59	1.134	12. Gloomy	50	1.362			
3. Stumble	56	1.556	24% Average		1.354			
4. Consider	54	1.675						
5. Read	50	1.590	1. Ragged	48	1.573	1. Cow	48	1.488
6. Rob	50	1.498	2. Boisterous	47	1.408	2. Physician	48	1.360
12% Average		1.452	3. Weary	47	1.196	3. Hell	45	1.334
			4. Sandy	47	1.147	4. Cup	42	1.092
1. Follow	48	1.308	5. Shady	47	1.063	14% Average		1.319
2. Tell	48	1.210	6. Nice	46	1.352			
3. Owe	48	1.206	7. Dark	45	1.131			
4. Come	48	1.140	8. Fresh	41	.961			
5. Provide	47	1.490	9. Bashful	40	1.199			
6. Believe	47	1.213	10. Slippery	40	1.063			
7. Borrow	41	1.224	20% Average		1.207			
8. Allow	40	1.231						
9. Forgive	40	1.210	1. Poor	38	.996	1. Stork	39	1.344
18% Average		1.248	2. Ripe	34	1.046	2. Needle	33	1.496
			3. Bright	33	1.107	3. Mattress	31	1.363
1. Lend	32	1.408	4. Handsome	30	1.284	4. Husband	10	.969
2. Reap	31	1.187	5. Muddy	30	1.103	14% Average		1.293
3. Bake	28	1.091	6. Rich	28	1.000			
6% Average		1.239	7. Feeble	25	1.015			
			8. Windy	20	1.040			
			16% Average		1.074			

*In the tabulation of the nouns in this table numbers 1, 9, 18, 23, 31, and 32 found in Table B - 3 were not used. The number of times that the stimulus was interpreted as a noun in each of these cases - ranging only from four to seven - was so small that the averages obtained from them could hardly be considered as fair average noun reactions.

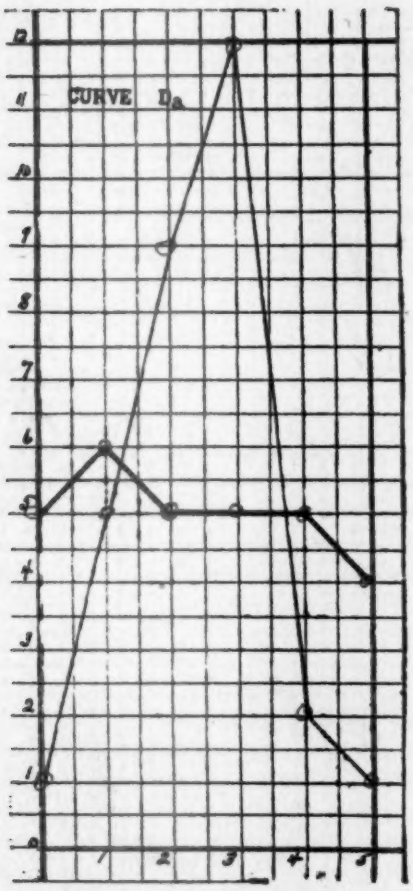
In this table we have each of the three verbal forms of stimuli arranged in separate groups. The different stimuli of each of these groups are arranged in the order of their percentage of distribution of responses. This percentage is shown in the first column after the stimulus words. In the second column is given the average of all the reaction times to each particular word. This table also shows the perdentage of each group of stimuli falling within each 10% range of percentage of distribution (with the exception of the upper range which is taken as between 80% and 100%, and the lower range, which is taken as between 10% and 40 %.) Together with each range is given the average of all reaction times falling within that range for each group of stimuli.

CURVE C_a.



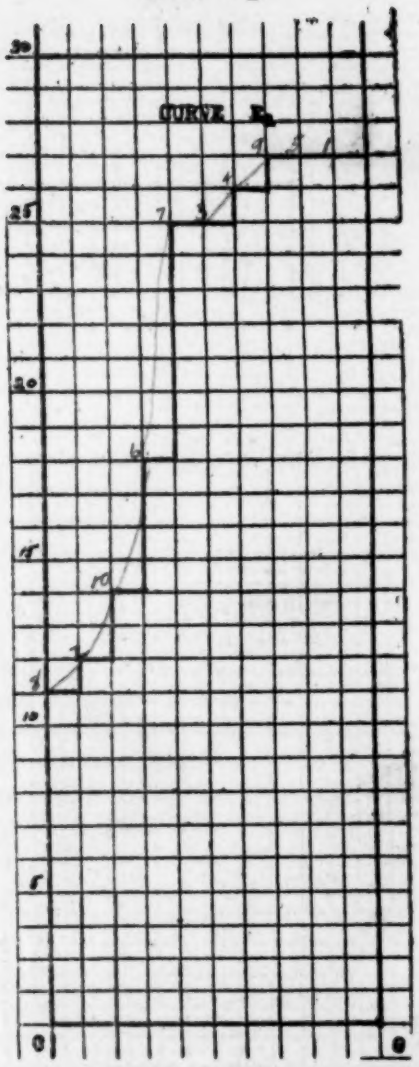
Curve C_a shows the percentages of distribution of responses for the three different forms of verbal stimuli; Verbs ····· , Modifiers ——— , and -·-·- Nouns. On the ordinate are shown the percentages of the various forms of stimuli having percentages of distribution corresponding to the numbers shown on the abscissa. For example, there are 10% of all the verb stimuli that have percentages of distribution ranging from 80 to 100.

CURVE D_a



Curve D_a shows the influence of direct (light line) and indirect (heavy line) order of pairs, 5 each, over the 30 cases. The ordinate represents the numberof cases, the abscissa the number of successful influences.

CURVE E_a.



In Curve E_a the units along the abscissa represent pairs of and form stimuli. The units on the ordinate represent the number of successes out of a possible 30. The varying degree of success of the various pairs is thus shown.

TABLE E_c.

Stimuli.	Responses.
Pork and	Meat, Pork -chop, Sausage.
Bread and	Butter(13), Water (4), Knife.
Horse and	Carriage, Cat, Cow, Waggon, Wheel.
Crackers and	Soup, Butter, Jam, Milk.
Ham and	Bacon, Beans, Cheese.
Liver and	Onions, Meat, Eggs (3), Heart, Lungs, Gravy, Cheese, Lead, No Reply, Ham.
Sing and	Hall, Sing in Bliss, Sing Sing, Play Music.
Coffee and	Tea(6), Milk (3), Buns(3), Muffins, Bread, Wafers, Doughnuts, Cake, Sugar, Butter.
Ice-cream and	Candy, Soda, Pie.
Biscuit and	Bread(8), Doughnuts (2), Honey (2) Eggs (2), Coffee, Milk.

The above table shows the distribution of the unsuccessful responses to the and form of influence In cases in which the unsuccessful response was given more than once, the number of times that it appeared is given in parentheses.

TABLE F_a.

Interpreted as Noun?

	A	B		A'	B'
Watch	71%	74%	Pick	35%	43%
Jar	100	91	Boil	22	43
Match	71	87	Sign	100	57
Pound	83[a]	75[b]	Fit	57	43
Train	71	95[c]	Stand	39	57

Stimuli used adjectively considered the same as those used substantively

a 6 cases only. b 30 cases only
c 22 cases only

A = preceded by noun form 7 cases
B = preceded by noun form 23 cases
A' = preceded by verb form 23 cases
B' = preceded by verb form 7 cases

The average % for A and A', 57%
The average % for B and B', 76%

TABLE D - 1.

Subjects 1 / Stimuli:	1	2	3	4	6	7	8	% of successes	Av.reac. of successes
Lunch Counter	1.134		.654				1.125	43	.971
Sweeper Carpet			1.386	1.880		1.706	1.729	57	1.675
Chimney Sweep			.769	1.053			1.251	43	1.024
Store Drug			.710	.821	.629	.900	.826	71	.777
Salt Pork								0	
Box Music				.895	.879		.924	43	.899
Suit Case					.960	.789		29	.875
Cushion Pin			.585	.681	.683		.777	57	.683
Coal Bin		1.798		1.009	.768	.840	.831	71	1.049
Syrup Maple			.838	.453	.672	1.157	.898	71	.800
Av. React. of Dir.Suc.	1.134	1.798	.713	1.031	.864	.814	1.069		
of Ind.Suc.			.880	.942	1.216	1.264	.831		
Gen. Av. (From TableA.)	1.157	1.969	1.479	1.117	.881	1.497	1.194		
D Successes	1	1	2	2	2	2	3		
T Successes	-	-	4	5	4	3	5		

TABLE E.

Subjects - 1 / Stimuli:	1	2	3	4	6	7	8	9	10[b]	11	12
Beans Pork and	1.049	1.909	.484	1.233	Meat .474*	1.042	2.299[a]	1.675	P.Chop 2.854*	1.540	.794
Milk Bread and	Butter .782*	Water 1.460*	1.073	Water .834*	.898	Butter 1.113*	Butter 1.103*	Butter .964*	Butte 1.917*	1.153	Butte .963*
Buggy Horse and	.803	Carriage 1.569*	.900	.853	.693	.889	1.006	1.307	Cat 2.326*	1.244	.967
Cheese Crackers and	.739	1.926	.710	.746	.814	.889	.861	1.721	Soup 3.640*	1.726	.718
Eggs Ham and	.843	1.118	1.034	.738	.720	2.825	.935	.969	Bacon 1.224*	1.399	.709
Bacon Liver and	1.587	1.447	Onions 1.840*	Meat .913*	Eggs .664*	.749	1.061	2.711	1.057	1.176	Heart 2.060*
Dance Sing and	.573	2.929	1.651	.942	Hall .904*	.898	.871	c 3.009*	.563	1.984	.726
Rolls Coffee and	.632	1.756	1.034	.944	.875	Buns .893*	Tea .763*	1.645	Milk 2.784*	1.134	.836
Cake Ice-cream &	Candy .728*	1.256	1.050	Pie .820*	.895	.721	.985	.762	2.234	1.923	.786
Butter Biscuit &	1.066	Milk 3.541*	d 1.237*	Eggs 1.082*	.872	d 1.753*	Bread .772*	1.195	Coffee 2.399*	1.104	2.041
Av. Suc.	.915	1.763	.991	.893	.824	1.145	1.144	1.488	1.285	1.428	.947
Av. Unsuc.	.755	2.123	1.539	.915	.711	1.258	.879	1.987	2.449		1.533
Av. Both	.833	1.871	1.100	.901	.790	1.177	1.065	1.600	2.100	1.428	1.062
Gen.Av.[e]	1.157	1.969	1.479	1.117	.881	1.497	1.194	2.347	2.094	2.591	1.404

a "Couldn't read test word at first." b Note that #10 a student from China has the least
d Doughnut. e From Table A 1-32. f Sing Sing. g Time lost by apparatus
influence was not successful. The words above these cases are the responses in

TABLE D - 2.

	10	11	12	13	14	15	16	17	19.	20	21	22	23
									.850		.806		
		1.368	1.966		1.366		.836	1.206	.945		1.239		
			.973		3.987*		.684	1.139	.982		.818	.906	.81
41	2.235		1.201	.995	.948		1.022			1.363	.817	.978	
			1.470		1.257				.654		.824		1.08
					1.181			1.13					
			.639		.956		1.153				.764		
3			1.954	.898	1.101			1.582	1.265		.559	1.034	
9				.717	.965	.890		1.245	.724		.801		.91
4	1.169	1.118	1.032	.802	1.624	1.457	1.533	1.48	1.070	.952		1.181	
8	2.202	1.243	1.538	.898	1.244	1.457	1.127	1350	1.093	1.157	.868	1.064	
9			1.027	.717	1.791	.890	.918	1191	.805		.803	.906	.93
7	2.094	2.591	1.494	1.261	3.047	1.654	1.124	2.406	1.094	1.490	.971	1.189	1.08

of anything. Answer finally suggested by the previous work."

2 2 4 3 5 1 3 4 3 2 3 3 -
- 3 1 4 1 2 2 4 - 3 1 3

12

	13	14	15	16	17	19	20	21	22	23	24	25	26	27
.794										Sausage				
Butte	.234	1.256	1.183	.973	1.880	1.324	.898	1.172	1.041	1.887*	.933	.787	1.378	.89
.963*		Butter	Butter		Water	Knife			Water		Butter	Butter	Butter	
	960	1.046*	1.069*	.897	1.183*	1.371*	.764	.830	.833*	1.063	.886*	.759*	1.086*	.74
.967										Cow				
	903	.884	1.183	.711	.993	.699	1.057	.788	.818	1.042*	.699	.598	1.054	.72
.718						Jam							Butter	
	132	1.266	1.049	.725	.960	1.499*	.704	g	.875	.725	.616	.736	1.560*	.90
.709						Cheese				Beans				
Heart	.713	.655	.961	.709	1.124	1.063*	.855	.617	.900	.651*	.672	.665	.847	1.05
2.060*	ings		Gravy			Cheese	Eggs	Lead		h	Ham			
	.049*	.894	5.579*	1.480	1.570	1.354*	2.670*	.948*	.998	1.066*	.984*	.498	1.254	.75
.726					f				Play				Music	
	.170	2.485	1.393	.794	5.872*	.949	1.111	.964	.920*	.831	.852	.792	1.699*	.93
.836	ea		Milk		Wafers	Tea	Sugar	Bread		Tea	Buns	Butter	Tea	Tea
	.889*	.960	.892*	.703	3.764*	1.257*	1.584*	.863*	1.015	.742*	.756*	.598*	1.828*	.98
.786			Soda											
	.106	1.071	.929*	.837	1.174	.741	.772	1.908	.922	.823	.901	.599	1.085	.83
2.041	read	Bread		Bread	Honey					Bread			Bread	Brea
.947	.846*	2.535*	1.290	1.011*	2.200*	.976	1.801	.971	1.196	.837*	.913	.513	1.886*	.76
1.522														
1.063	.044	1.181	1.166	.869	1.284	.938	.995	1.036	.971	.861	.795	.647	1.124	.85
1.404	.261	1.791	2.117	1.011	3.255	1.309	2.037	.906	.876	1.038	.875	.679	1.612	.87
	.109	1.303	1.547	.885	2.072	1.123	1.202	1.007	.953	.967	.819	.653	1.368	.8
least	.261	3.047	1.654	1.124	2.406	1.094	1.490	.971	1.189	1.080	.889	.769	1.978	1.0

ber of successes of any subject, while #26, a Chinese student who has lived in this country practically
working. h No reply given. i The average saving for each of the ten pairs. * The cas
) cases.

19.	20	21	22	23	24	25	26	27	28
.850		.806						1.540	
.945		1.329			1.258	1.232	1.339	1.144	
.982		.818	.906	.811	.900	.682		.971	
	1.362	.817	.978				1.327	.839	.424
.654		.824		1.089				.749	.410
		.764			.586		.919	.884	
1.265		.559	1.034			.638	1.335		1.00
.724		.801		.913	.736	.533	2.046	.913	
1.070	.952		1.181			.432		1.164	1.16
1.093	1.157	.868	1.064		1.258	.767	1.334	1.049	.86
.805		.803	.906	.938	.741	.608	1.483	.722	.72
1.094	1.490	.971	1.189	1.080	.889	.769	1.978	1.023	.79
3	2	3	3	—	1	3	3	3	3
4	—	5	1	3	3	2	2	5	1

	23	24	25	26	27	28	29	30	31	
1	Sausage 1.887*	.933	.787	1.378	.897	.575	.970	.826	.690	1.
r 3*	1.063	Butter .886*	Butter .759*	Butter 1.086*	.745	.429	Butter .902*	.950	Butter .321*	1.
8	Cow 1.042*	.699	.598	1.054	.725	.333	.678	Waggon .664*	Wheel .642*	1.
5	.725	.616	.726	Butter 1.560*	.909	.375	.693	Milk .988*	.686	.
0	Beans .651*	.672	.665	.847	1.059	1.156	.869	.679	.614	.
8	h 1.066*	Ham .984*	.498	1.354	.752	.634	Eggs 3.810*	.639	.706	1.
0*	.851	.852	.792	Music 1.699*	.923	.473	.762	.689	.666	1.
5	Tea .742*	Buns .756*	Butter .598*	Tea 1.828*	Tea .989*	Muffins 1.860*	Buns .646*	Milk 1.407*	d .452*	Ca 1.
2	.823	.901	.599	1.085	.836	1.053	1.180	.799	.771	1.
6	Bread .837*	.913	.512	Bread 1.886*	Bread .769*	.758	.820	Eggs .886*	Bread .618*	Ho 1.
1	.861	.795	.647	1.124	.853	.643	.853	.762	.689	1.
6	1.038	.875	.679	1.612	.879	1.860	1.786	.986	.503	1.
3	.967	.819	.653	1.368	.858	.764	1.133	.852	.615	1.
9	1.080	.889	.769	1.978	1.023	.797	1.280	1.183	.658	1.

has lived in this country practically all his life. c Sing in Bliss.
ch of the ten pairs. * The cases in which the

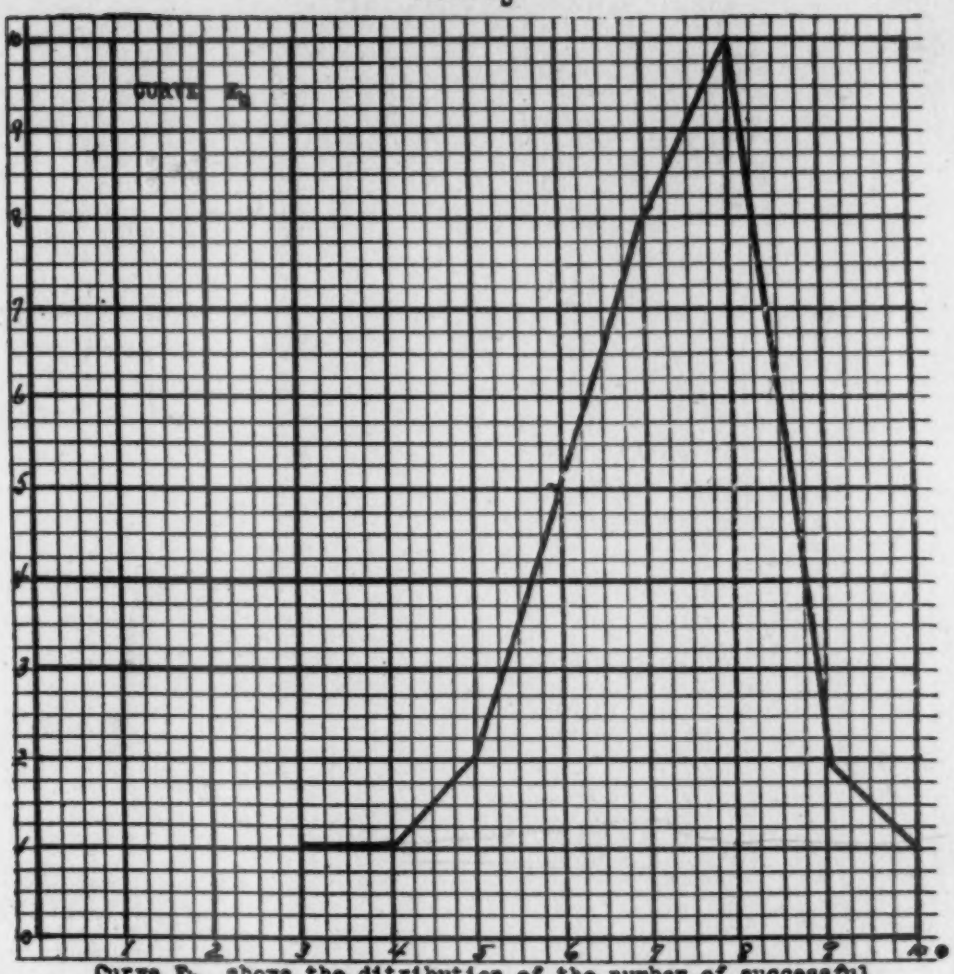
7	28	29	30	31	32		
40				.323		17	.882
44					.951	52	1.237,
71		1.014	.717	.491	1.177	68	1.083
39	.424			.917	1.250	61	1.118
749	.410		.763			35	.903
						9	1.157
884			1.257			35	.895
	1.007		1.185			52	1.153
913		.668	.545	.270		65	.915
164	1.164	1.216	1.016	.602	1.201	83	1.134
049	.865	1.216	1.101	.760	1.134		
723	.723	.410	.821	.831	.361		
023	.797	1.280	1.123	.658	1.367		
3	3	1	2	2	3		
5	1	2	4	3	1		

31	32	A	B	C	D
.690	1.282	90	1.159	1.758	-.579
Butter					
.321*	1.367	40	.936	1.033	-.097
Wheel					
.642*	1.093	83	.872	1.249	-.377
.686	.740	87	.921	1.922	-1.001
.614	.633	90	.922	.979	-.057
.706	1.500	60	1.149	1.996	-.847
.666	1.055	83	1.081	2.481	-1.400
d	Cake				
.432*	1.183*	37	1.047	1.259	-.213
.771	1.079	90	1.494	.826	+.668
Bread	Honey				
.618*	1.407*	47	1.108	1.474	-.366
					-.458[1].
.689	1.092				
.503	1.295				
.615	1.133				
.658	1.367				

in Bliss.

A = % of successful influences
B = Av. Reaction time of these successful influences.
C = Av. Reaction time of the unsuccessful influences
D = Difference between B and C

CURVE E_b.



Curve E_b shows the ditribution of the number of successful controls of the and form over the individual cases of the 30 cases tested. On the abscissa are given the successes and on the ordinate are given the number of cases.

TABLE F - 1.

Preceded by Noun Form								Preceded by Verb From							
	1	2	3	4	6	7	8		1	2	3	4	6	7	8
Watch	N	N	N	N	N			Pick	V	V	V	V			
Jar	N	N	N	N	N	N	N	Boil	V	V	V	V			
Match		N	N	N	N		N	Sign	V		V			V	
Pound		O	N	N	N	N	N	Fit	V		V	V			
Train		N	N	N	N		N	Stand	V	V	V			V	

TABLE F - 2.

Preceded by Verb Form

	9	10	11	12	13	14	15	16	17	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Watch								V		V	V		V									V	V
Jar							V															V	
Match															V						V	V	
Pound		O						O			V			V	O				V	V	V		
Train														O							V		

Preceded by Noun Form

	9	10	11	12	13	14	15	16	17	19	20	21	22	23	24	25	26	27	28	29	30	31	32
k	N	N	N	N	N					N					N		N						
		N			N					N				N				N					
	N	N	N	N	A	A	A	A	A	N	N	A	A	A	A	A	A	A	N	A	A	A	A
	N		N	N	N		N		N	N	N	N		N		N	N		N				
1	N		N	N	N	N		N				N		N			N						

Tables F - 1 and F - 2. In these two tables are given the results h the ten ambiguous verbal forms appearing under the two different conditions - preceded by ten definite verb forms, preceded by ten definite noun forms. At the head of each column of results is given the number of the subject whose reaction are therein presented. The letters in the columns signify the interpretation given the ambiguous stimulus word: V, verb; N, noun; A, adjective; O, ambiguous. The ambiguous reactions are omitted from the calculations made in the text. When no letter appears in the column it means that the interpretation of the ambiguous form is of a character opposite to th at of the ten preceding definite forms.

TABLE G.

Subjects - 1		2[b]	4	6	7	8	
Stimuli:							
Nationality	Jew	Jewish	Is'lite	Jews		Swede[a]	Jew
	1.677	2.539	.750	1.807		2.764	3.0
Tom	Cabin	U. Tom	Brown	U. Tom	Uncle		U.T
	.833	2.119	.492	1.033	1.146		.7
Organ	Grinder	Grinder	Monkey	Monkey	Dago	Monkey	H.C
	1.474	1.051	1.455	1.327	1.179	1.588	1.0
Brush				Sage	Cactus	Sage	Woo
				1.420	.690	1.509	.9
Shrill[f]							
Av. Suc.	1.328	1.903	.899	1.369	1.005	1.954	1.2
Av. Unsuc.							.9
Gen. Av.[g]	1.157	1.969	1.117	.881	1.497	1.194	3.3

Table G gives the results of the tests for the influence of condition. Just before each stimulus the subject was told to be en situation. These situations were: for Nationality - A burni for Tom - Slavery times down South just before the Civil War; f Italian quarter in a large city; for Brush - The Great American - The manufacturing district of a large city, just at the noon h umns for the different subjects appear the reactions to the vari mediately under each such reaction appears its reaction time. B are caused by omission of the stimuli, failure of response, misu structions, etcetera.

• Considered as cases of unsuccessful influence.

8	9	10	11	12	13	14	15	16	17	1
ede[a]	Jew	German*	Jew	Jew	Jew	It'ns†	Clerks*	Jew	Nat'l*	Jew
764	2.055	2.064	1.319	1.766	1.641	3.410	1.355	1.395	4.311	1.4
	U.T.C.[c]	U.Tom	UTC [c]	UTC[c]	Cabin	UTC[c]	Uncle	Whips	h*	Unc
	.705	1.533	- - -	1.379	.776	.865	1.379	1.115	1.835	- -
nkey	H.Organ	Play[d]	O.Gr'r		Grinder	OG[j]	Pipe*	Junk S†	Recital	Gri
588	1.032	4.371	.705		1.027	1.886	1.260	.809	1.319	1.1
ge	Wood*	Brush	e*	Brush	Sage			Sand*	Tush*	Hen
509	.909	1.570	7.390	1.015	1.743			.885	1.447	1.1
954	1.264	2.491	1.012	1.386	1.297	1.376	1.279	1.255		1.2
	.909	2.064	7.390			3.410	1.308	.847	2.328	
194	2.347	2.094	3.591	1.494	1.361	3.047	1.654	1.124	2.406	1.0

luence of a given preceding
old to be thinking of a gi-
- A burning clothing store;
l War; for Organ - An
American Desert; for Shrill
he noon hour. In the col-
the various stimuli. Im-
time. Blanks in the columns
onse, misunderstanding of in-

a "Last big fire that I remember was in Omaha. Was burned. When I saw Nationality I thought of tha connected up with Swede."
b Number three was not tested with these stimuli
c Uncle Toms Cabin.
d "Saw man and woman playing hand organ on the stre couldn't think what called man that turned the c
e White-wash brush.
f Not given to any of the subjects until #21.
g From Table A 1-33.
h Tomikins
i "Thought of time that Uncle Tom was sold down Sou
k " Had picture of sage brush after the word was gi
j Organ Grinder.

9	10	11	12	13	14	15	16	17	19	20	21	22
w 055	German* 2.064	Jew 1.319	Jew 1.766	Jew 1.641	It'ns† 3.410	Clerks* 1.355	Jew 1.395	Nat'l* 4.311	Jew 1.491	Sheeny 1.075	Jew 1.087	German* 5.039
T.C.[c] 705	U.Tom 1.533	UTC [c] - - -	UTC[c] 1.379	Cabin .776	UTC[c] .865	Uncle 1.279	Whips 1.115	h* 1.835	Uncle. - - -	Auct. .766	Uncle .832	W.Post 1.000
Crgan 032	Play[d] 4.371	O.Gr'r .705		Grinder 1.027	OG[j] 1.886	Pipe* 1.260	Junk S† .809	Recital* 1.319	Grinder 1.168	F.Stand* 1.467	Monkey .791	H.Organ 1.195
od* 909	Brush 1.570	e* 7.390	Brush 1.013	Sage 1.743			Sand* .885	Tush* 1.447	Hen[k] 1.118	Bones[l] 3.721	Sage .698	m. 3.770
											Men* .600	Whistle 1.961
264	2.491	1.012	1.386	1.297	1.376	1.279	1.255		1.259	1.521	.852	1.982
909	2.064	7.390			3.410	1.308	.847	2.238		1.467	.600	5.039
347	2.094	3.591	1.494	1.261	3.047	1.654	1.124	2.406	1.094	1.490	.971	1.189

f a given preceding
e thinking of a giv-
ing clothing store;
for Organ - An
n Desert; for Shrill
hour. In the col-
ious stimuli. Im-
Blanks in the columns
nderstanding of in-

a "Last big fire that I remember was in Omaha. Was a white headed fireman burned. When I saw Nationality I thought of that and finally white headed connected up with Swede."
b Number three was not tested with these stimuli
c Uncle Toms Cabin.
d "Saw man and woman playing hand organ on the street. Reason for long time, couldn't think what called man that turned the crank."
e White-wash brush.
f Not given to any of the subjects until #21.
g From Table A 1-32.
h Tomikins
i "Thought of time that Uncle Tom was sold down South." [of brush hen.
k " Had picture of sage brush after the word was given and that made me think
j Organ Grinder.

22	23	24	25	26	27	28	29	30	31	33
German*	Jew	Jew	Fire*	Jew	German*	Jew	Irish*	Fire'p*	Jew	Jewish
5.039	.346	.891	.385	1.319	.910	.591	1.516	1.453	.629	3.365
W.Post	Harry*	Thumb*	Jerry*	Whip'g.	McQuir[s]	Uncle	Uncl[e]	Black[n]*	o *	Cabin
1.000	.934	1.451	.755	1.204	1.270	.730	1.64[1]	1.578	.797	1.144
H.Organ	Grinder	Grinder	Riis[p]	Monkey	Ch'l'n[q]	Chianti	Grind[r]	Grind	Grinder	Grinder
1.196	.834	1.107	.370	1.194	1.743	.585	1.11[1]	1.054	.736	3.559
m.	Wood*	Fence*	Fire*	Cactus	Dry[r]	s*	t	Empty*	Wood*	Dust*
3.770	.989	.974	.808	.726	.831	.604		1.430	.741	3.014
Whistle	Whistle			Whistle	Whistle	Whistle	Whistle	Loud*	Cry*	Whistle
1.961	1.342[u]			1.943	2.241	- - -	1.08	2.156	1.176	3.111
1.982	.841	.999	.270	1.277	1.602	.661	1.28	1.054	.683	3.270
5.039	.962	1.213	.649		1.090	.96	1.51[1]	1.654	.905	3.111
1.189	1.080	.889	.769	1.978	1.025	.97	1.28[9]	1.123	.658	1.367

eman headed

g time,

hen. e think

1 "Saw sage brush and bleaching bones on th[e] sand. Hadn't had any bones in my picture until the word brush was seen. [H]ad to change my picture when the word brush came, because didn't have it [i]n the picture. Was twenty mule borax team."

m Camel's tail.

n "Black Tom, not Uncl[e] Tom.

o The Boot Black.

p Jacob Riis.

q "Thought of a lot of [c]hildren around [a]n organ grinder."

r "Thought of bush out there. Barreh. Dry could express the appearance of it"

s Salamander

t By mistake this stimulus was given with te[s]t situation as was usually given for the stimulus organ. The respon[se] shoe. The introspection - "When the condition was given saw a street [o]f Italians. After the test word came, also saw little Italian shoe-bo[y] brushing shoe." This is interesting as showing how the same situation [i]nced two separate reactions for the same individual.

u "Couldn't make out the test word at first."

INCHES
1
2
3
4
5
6
C2399
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
METRIC